SCIENTIFIC AMERICAN
No. SUPPLEMENT 652

Scientific American Supplement, Vol. XXV., No. 652.
Scientific American, established 1845.

NEW YORK, JUNE 30, 1888.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

DISINFECTION.

NO. I.

DISINFECTION, in some shape or other, of the clothes and bedding of patients suffering from contagious disorders is by no means a modern precaution against the spread of disease. Among the numerous prophylactic measures proposed by earlier authorities, destruction by fire was perhaps the simplest and safest; but as it involved a serious loss of property to the already sufficiently afflicted sufferer, or to his belongings, and thereby to the general community, this treatment was rather heroic than economical. Different chemical solutions, such as carbolic acid, corrosive sublimate, chloride of lime, caustic soda, quicklime, etc., as well as fumigation with chlorine, bromine, and sulphuric acid, have, from time to time, been employed with varying success. In some instances they proved fatal to the bacillus, in most to the articles disinfected.

The negative results of these empirical remedies reflects no discredit on the philanthropic intention of their advocates. Their efforts were directed against an unknown foe. It was left to the careful and untiring investigations of the bacteriologist to penetrate the mysterious existence of the unseen germs of disease, to discover the condition of their development, and to determine the means for their destruction.

Professor Koch is the first in the rank of these investigators. To his initiative we owe not only the assumed certainty with which the form and conditions of existence of numerous germs of disease which, prior to his researches, were imperfectly understood or scarcely suspected, may be determined in the laboratory, but also the impetus to discovering the simplest and surest way to destroy them, and to apply scientific results to general practice for the public good.

The investigations which he initiated have been studiously followed and amplified by others; and new bacteria are being daily added to the long list of the invisible enemies to life. It must not, however, be supposed that the task of the savant ceases here. Technical knowledge requires his further assistance in the practical application of the means to the end; as although the real burden of sterilization devolves on the engineer, his efforts must be guided and his results controlled by bacteriological experiments. This has been no easy task, as difference of opinion is no less common between professors than between any other two of a trade; nor has this difficulty been lessened by considerable inconsistency and an occasional change of front, and the unfortunate engineer has had to play the ambiguous and unenviable *role* of shuttlecock between contending theorists. The several mechanical appliances for disinfection taken in the ascending order of value and priority of construction are hot air; hot air and steam acting independently of each other; hot air and steam acting alternately; hot air and steam acting in combination; hot air in the casing and steam in the interior of the chamber; steam under pressure; and steam acting as a live current without pressure.

Hot Air Disinfectors.—The uncertainty of action of these stoves has been fully demonstrated by Drs. Koch, Wolffhugel, Gaffky, Loeffler, and others, who found that although fully developed bacteria exposed to a temperature of 212 deg. for an hour and a half were destroyed, the germs of the same, after an exposure of three hours to a temperature of 284 deg., were as fertile as ever, while the clothes were singed and spoilt; therefore, it is scarcely necessary to refer to them, unless to record their failure and to mark their degeneration in the social scale. There are still a goodly number on the Continent, but how fallen from their high estate! No longer relied upon to protect humanity against the contagion of insidious disease, their capacity is degraded to the destruction of the visible and obtrusive parasites which irritate the wearers of dirty clothes, and to the performance of an ignominious task in casual wards and gaols. But even here their advantages are not unmixed, as on the one hand the insertion of the head of a lucifer match insures the destruction of a whole charge and necessitates the provision of new clothes for the owners—a favorite trick; and on the other, owing possibly to some analogy between the hardy growth of weeds on a fertile soil and vigorous vermin on a sturdy tramp, Dr. Wolffhugel found that in some cases objectionable insects appeared to revel in the unusual warmth.

Hot Air and Steam Acting Independently.—One form of this system is the apparatus constructed by MM. Symons and Huygens, of Rotterdam and Brussels. Its construction is shown in the accompanying Figs. 1, 2, 3, and 4. The products of combustion are led through flues surrounding the chamber, and the air heated by passing it through parallel flues in the opposite direction. Steam is generated in an open pan under the chamber. The temperature of the air is modified by deflection on to the surface of the water. The process of disinfection is divided into three periods. During the first, hot, dry air is admitted alone, to warm the sides of the chamber and its contents. In the second, the hot air valve is closed, and the infected articles exposed to the steam rising from the pan. This is the actual disinfection. In the last period, dry air of a lower temperature is again admitted to carry off the accumulated moisture. The current and escape of hot air and steam are effected by closing the stoke hole and converting the exhaust into a draught hole under the grate.

Hot Air and Steam Acting Alternately.—The disinfector of MM. Oskar Schimmel & Co., of Chemnitz, as shown in the accompanying Fig. 5, is entirely separated from the steam generator, which is placed in a separate locality. The air is heated by passing it over the steam heated radiators, C, until the temperature has reached 180 deg. During the second period the air valve is closed, and steam of 3 to 4 atmospheres pressure admitted through the valve, *i*. This, the actual disinfection, lasts 40 to 60 minutes, when the steam is shut off and the contents subjected to hot air alone for about an hour, when they can be removed in a tolerably dry condition. A modification of this, or rather a transition between this and the next type, is M. Bacon's apparatus, of Berlin. The same is shown as a "stationary" in Fig. 6, and as "portable" disinfector in Fig. 7. The steam and hot air can be used either alternately or simultaneously. The generators are combined

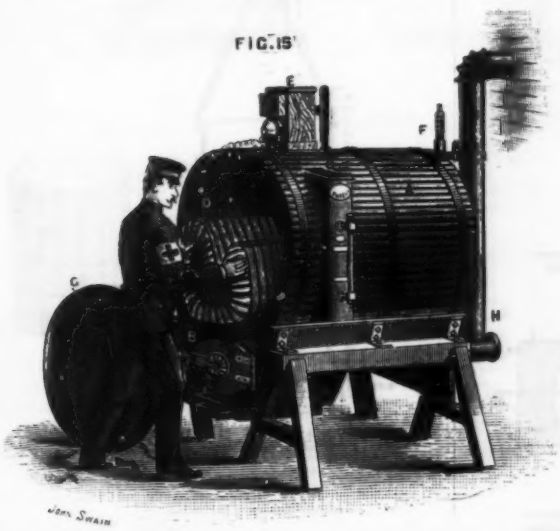
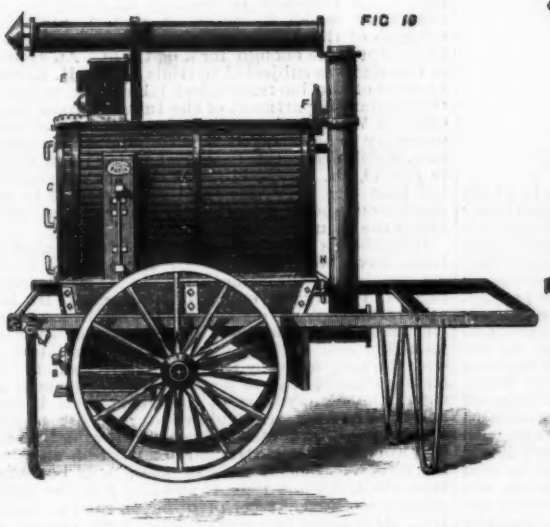
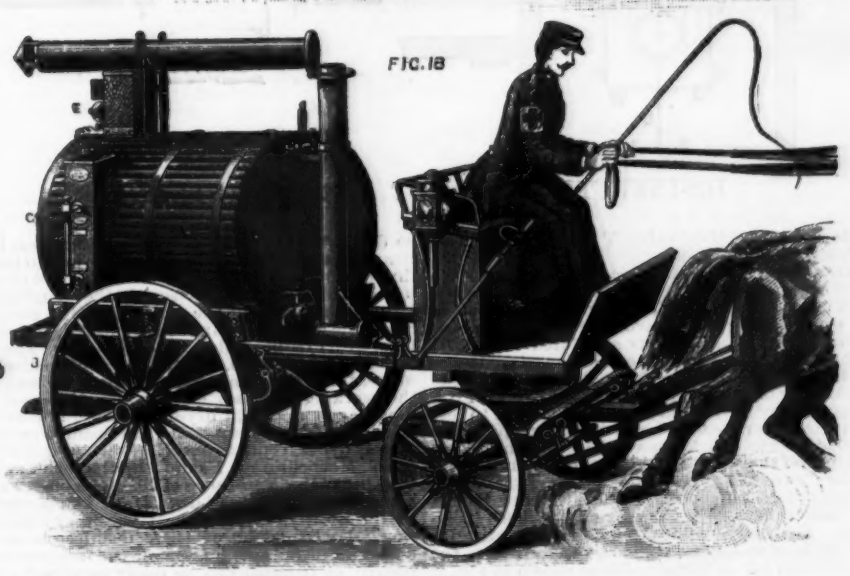


FIG. 17.

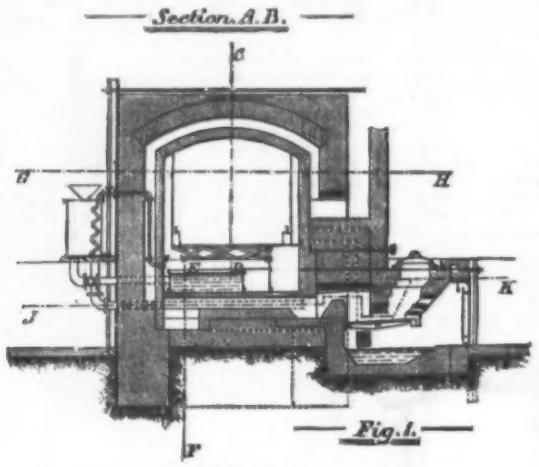


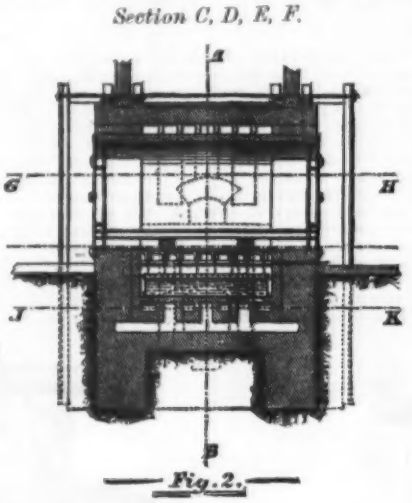


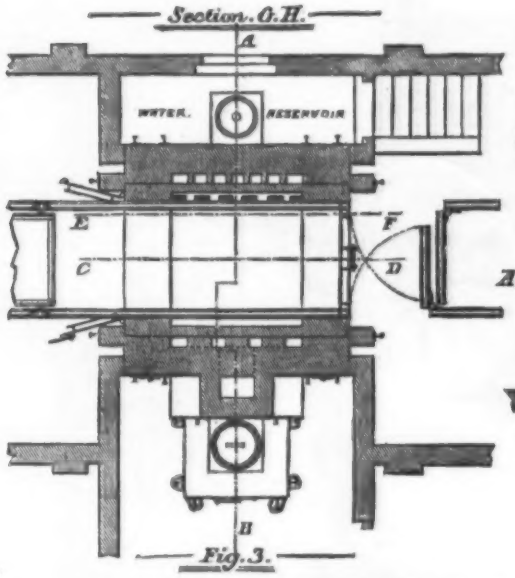
THURSFIELD'S STEAM DISINFECTING APPARATUS.

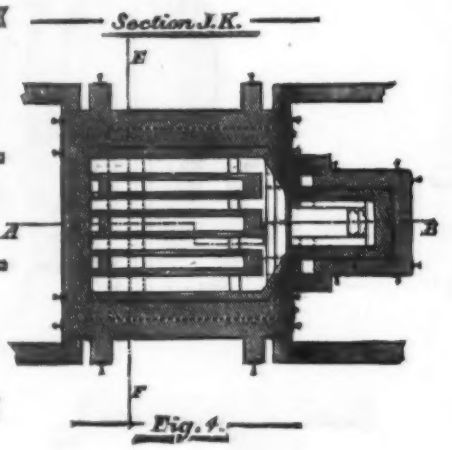
with the chamber. There are two hearths, T and D, the former for heating the air, and at the same time for generating a moderate—(?) very moderate—amount of steam, and the latter for heating the boiler alone, when a more copious supply of steam is required. During the first period the chamber is supplied with hot air alone. As soon as the temperature has reached 170 to 190 deg. the second commences, when steam of about 2 atmospheres pressure is either admitted alone, or simultaneously with hot air, until a temperature of 230 to 250 deg. has been attained. The steam is then shut off, and hot air admitted alone for 8 to 10 minutes for the purpose of drying the contents. In the accompanying figures, A is the grate, B the fire door, C the radiator, D the boiler, E the accumulator, F the steam inlet, G the air valve, K the air outlet, I the tube, G, and the valve, E, regulates the admission. Pure steam is admitted into the chamber by means of the valve, C. In the first period steam and hot air combined are admitted into the casing. As soon as the thermometer in the outlet registers 230 deg., which requires ten to fifteen minutes, the valve, E, is partially closed and steam admitted into the chamber by opening the valve, C. The temperature in the casing is maintained by a slight influx of hot air, so that condensation is practically prevented. The results of the bacteriological trials made by Professor Max Gruber, of the Hygienic Institute of the Vienna University, were most satisfactory. "Milzbrand" germs, the most resistant pathogenic organism, were completely sterilized after an hour's exposure.

Steam under Pressure.—Apparatus of this class must









DISINFECTING BY HOT AIR AND STEAM.

smoke stack, N the safety valve, T firing for dry heat, and D firing for boiler alone.

Hot Air and Steam Acting in Combination.—We described an apparatus of this class invented by Mr. W. E. Thursfield, an English engineer residing in Vienna, which, owing to the favorable opinion expressed by the committee of experts appointed to test its merits, has been largely introduced in Austria. It was not fated, however, to outlive the trials and vicissitudes of inconsistency of opinion and change of front. Prof. Bohn, deputed by the sanitary board of Vienna to test its prophylactic merits—for which purpose an apparatus was handed over to him for more than three months—certified in 1886 that "it fulfilled the requirements of a disinfector;" whereas at the Hygienic Congress held in the autumn of 1887 he confessed that the experiments had not been sufficiently exhaustive to establish its infallibility. Nothing remained but for the constructor to institute bacteriological trials at his own cost, the results of which led to the alterations shown in Fig. 8, which brings it under the class of

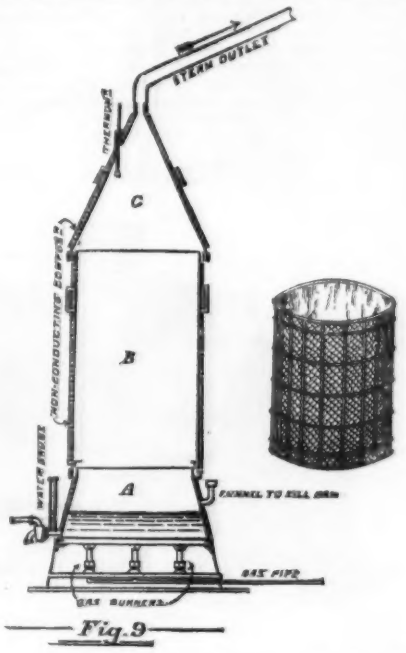
Hot Air in the Casing, and Steam in the Chamber.—In this apparatus the casing and disinfecting chambers are completely separated. The former is connected with the steam and hot air generator by means of the

be divided into two groups: (1) Disinfectors in which steam generated under pressure is allowed to pass freely through the contents of the chamber; and (2) disinfectors in which an equal pressure in the chamber is maintained with that in the boiler. Under group 1 are chiefly disinfecting chambers connected, for economy's sake, with existing boilers in hospitals, etc. The prophylacteral effect is good, but the excess of condensation is so great that many materials are thereby damaged, and the working expenses considerably increased, by the necessity of a special drying room for the disinfected articles. Under group 2 are the disinfectors of Washington Lyons, Geneste and Herrscher, Oskar Schimmel & Co., Moehrlin and Papin. In the latter apparatus, working under a pressure of 2½ atmospheres and with a temperature of 260·60 deg., M. C. Von Naegeli found that the distribution of heat was very irregular and slow. Each and all of these disinfectors attain the necessary heat; but that in all the temperature is not equally distributed can be easily imagined, especially when the shape of the chamber favors the formation of dead corners. The reason of this is obvious. The air contained in the articles to be disinfected, as well as in the chamber itself, has no means of escape, and offers, according to its volume and density, a greater or less resistance to the penetration of steam. Heydenreich proved this in Papin's disinfector, and found that the effect was better and more regular by allowing the steam to pass freely through the chamber sufficiently long to expel the air. Geneste and Herrscher recommend the same proceeding for at least five minutes in the directions for using their apparatus. Director Merke, of the Moabit Hospital in Berlin, has also verified the advantages of this procedure in a Schimmel's disinfector.

NO. II.

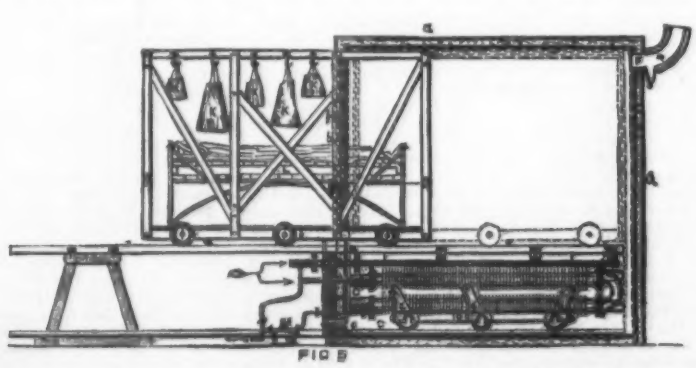
Steam without Pressure.—In their report to the Imperial Sanitary Office, in Berlin, Drs. Koch, Wolffhugel, Gaffky, and Loeffler say: "The experiments conducted have fully demonstrated that hot air even of 284 deg. is much less efficient as a disinfectant than steam—even with the steam rising from the surface of water free from salt—when infected articles are brought into immediate contact with it. In comparison with hot air, steam—whether acting with or without pressure—sterilizes the germs of disease much more quickly and with greater certainty. The heat of steam allowed to pass freely through the disinfecting chamber penetrates infected articles of whatever size much sooner than hot air, and with greater certainty than steam acting under pressure."

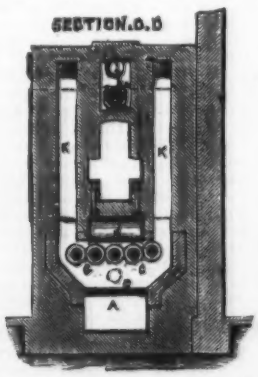
On the basis of these results, Dr. Koch constructed a laboratory disinfector, as shown in Fig. 9. The articles

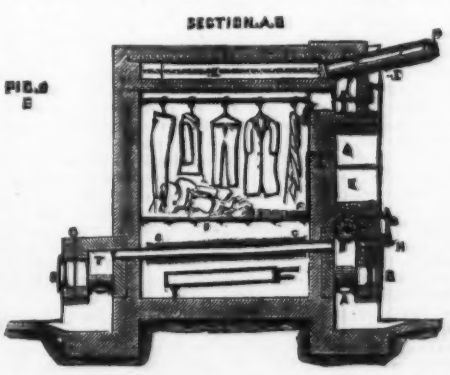


are placed in the basket and lowered into the chamber, and the cover, C, replaced. The steam rising from the pan, A, is sufficient to sterilize all bacteria. As a laboratory model its action is perfect, and on the strength of this Professor Pflugge has constructed an apparatus large enough for a mattress. An apparatus of this size was subjected to trials by Dr. H. Kowalski, director of the bacteriological laboratory attached to the sanitary department of the Imperial Austrian War Office in Vienna. Apart from the copious condensation naturally to be expected from so large an exposed surface, which necessitates a special drying room, as shown in Fig. 10, Dr. Kowalski found that the penetration of the heat was very slow and too irregular to be depended on, and he rejected the apparatus as "not fulfilling the requirements of hygiene."

Henneberg's disinfector, with which most satisfactory trials have been made by Dr. Esmarch, of Berlin, is constructed on the same principle. The obstacles to success in Pflugge's enlarged specimen of Dr. Koch's apparatus, copious condensation and irregular penetration of the steam, have been overcome by a better jacketing and by the introduction of radiators in or over the pan, whereby the air and articles in the disinfecting chamber can be warmed before steam is generated, the temperature of the steam itself increased, and the moisture accumulated during the process of disinfection evaporated before withdrawing the charge. The apparatus is constructed in a portable and stationary form. A general idea of both will be obtained from the following, Figs. 11 and 12. A is the cylindrical disinfecting chamber pivoting on the two brackets, C C. G is a cast iron pan or boiler with vertical internal radiators from the flange to the base, the lower portion of which serves to increase the boiler, the upper portion the air-heating surfaces. L is the grate; H, the frame which forms the junction between boiler and chamber; O, the outlet for steam, shown en-

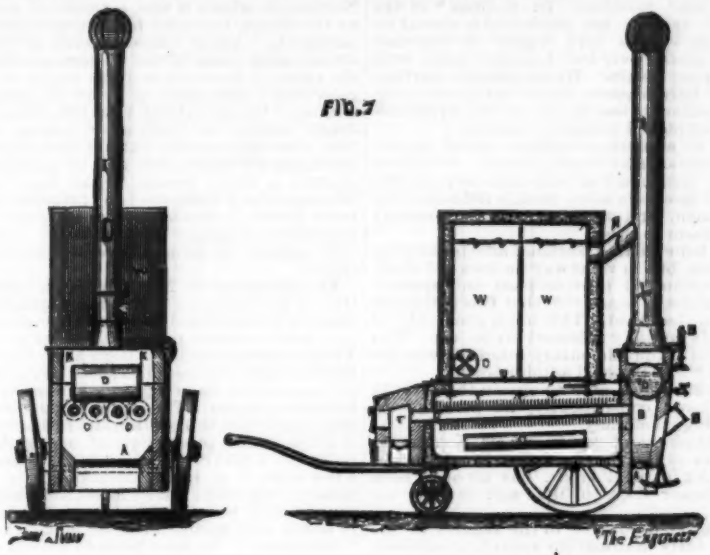






DISINFECTING BY HOT AIR AND STEAM.

larged in Fig. 13, with thermometer and condensation tube returning to the boiler through the funnel, N. M the water gauge, and K the throttle valve for directing the steam through the chamber or into the flue. In charging the apparatus the cylinder is slightly lifted in its bearing and placed in a horizontal position, the articles to be disinfected packed in the cage, Fig. 14, the latter inserted in the chamber, the bar, I, closed, and the cylinder returned to its previous position.

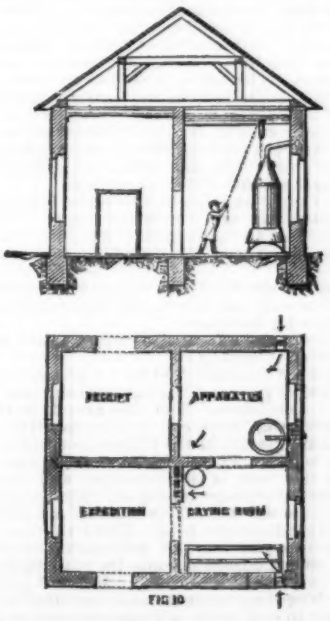


DISINFECTING APPARATUS.

In large disinfectors Mr. Henneberg returns to the square form as being less complicated. The practical experience fails to show whether the formation of dead corners will not have a prejudicial effect on the bacteriological result.

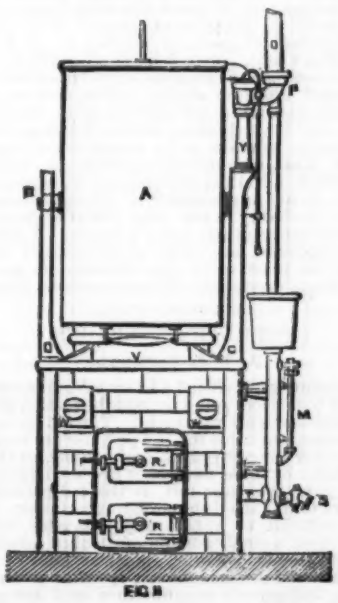
As will be seen from the illustration, the whole manipulation is somewhat complicated. There is a number of valves, cocks, etc., to be attended to, and something more than the average intelligence of an ordinary day laborer is necessary to insure a punctual and proper working of the apparatus.

It is impossible to satisfy the unreasonable demands of some people, whose ideas of a perfect disinfector seem to be that it shall cost nothing, occupy no space, and yet be sufficiently elastic to disinfect either a single suit of clothes or the contents of a whole house, be automatic in action, and convertible at will into stationary or portable. But the latest addition—Thursfield's

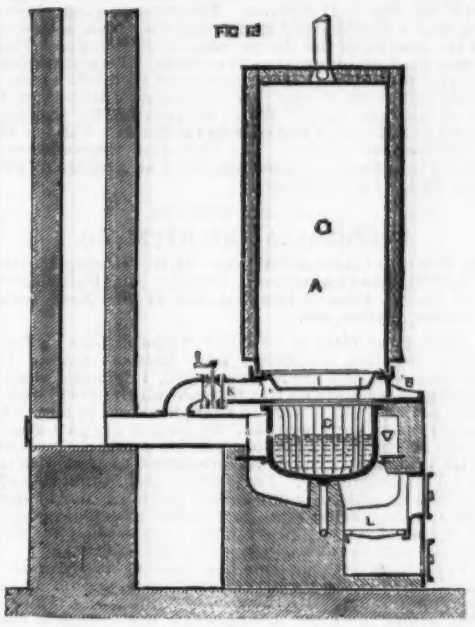


new and improved disinfector, with a current of live steam—appears to fulfill all that can reasonably be demanded of the constructor. The boiler, which is open, and, therefore, requires no safety valve, is formed by the annular space between two concentric cylinders, of which the smaller is the actual disinfecting chamber. The hearth is directly underneath, the heating surface large, and the space required comparatively small. As disinfecting chamber, boiler, and hearth are erected in one piece, a stationary apparatus can be converted into a portable by merely placing it on wheels. Its chief advantages, however, as a disinfector are that as the chamber is entirely surrounded by the boiler, its sides and contents are warmed *pari passu* with the water, condensation and radiation are entirely prevented, and there is no necessity for warming or drying the contents before and after. The process of disinfection is rapid, and the disinfected articles are withdrawn from the chamber so slightly damp that when shaken out they dry immediately in the hand. As the inlet and outlet for the steam are of the same dimensions, the current is continuous, the expulsion of air unrestricted, and the contents fully exposed to the thorough penetration of the steam. As the temperature in the contents curiously enough rises to 218 deg., and the pressure in the boiler, if there be any, cannot amount to more than one-twentieth atmosphere, this can only be accounted for by the steam imparting its latent heat by condensation.

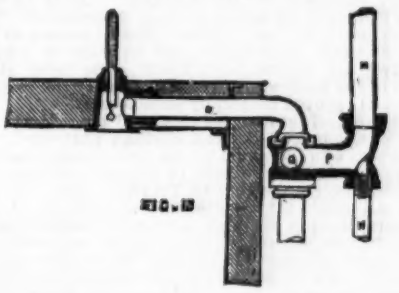
Figs. 15, 16, 17, and 18 illustrate the forms of apparatus adopted in Austria. The size of the chamber is sufficient for a single bed, complete with pillows, blankets, sheets, etc.; larger apparatus for hospitals are constructed with doors at both ends.



The apparatus has been subjected to a series of severe trials by Professor Dr. Max Gruber, of the Hygienic Institute of the Vienna University; by Professor Dr. Soyka, of the Hygienic Institute of the University in Prague; by Prof. Dr. Weichselbainn, Prosector and Professor of the Rudolf's Hospital in Vienna, by order of the sanitary department of the home ministry, who, on the strength of the favorable results—the sterilization in every trial of Milzbrand germs (the most resistant of any known pathogenic organism) after half an hour's exposure—issued a decree, on the 6th February this year, recommending its sole adoption to all communities in the empire; and lastly, by Dr. H. Kowalski, Regimental Surgeon and Director of the Bacteriological Laboratory of the Sanitary Department of the War Office, whose certificate, countersigned

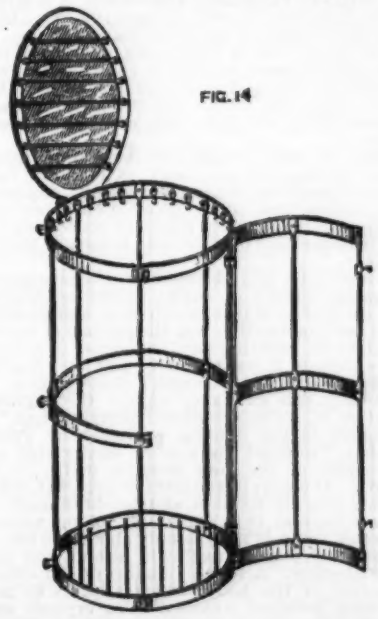


by Dr. Hoor, Surgeon-General to the Military Sanitary Committee, that "the disinfector satisfies every demand of hygiene," was only obtained after he had satisfied himself that the apparatus was able to sterilize not only Milzbrand germs, but the most resistant organism to be found in garden soil; so that it is equally reliable for destroying any future pathogenic organism yet to be discovered as for sterilizing those already known. The simplicity of manipulation as well as the



construction are exemplified in the "Directions for Use."

The boiler, A, is filled with water through the funnel, C, until the same rises to the upper mark on the water gauge. A brisk fire is then lighted in the hearth, B. The disinfecting chamber, D, is filled with the infected articles, either rolled or in the form of a bundle, which —according to ministerial decree—are to be placed in linen or sacks in the sick room and sprinkled with a 5 per cent. solution of carbolic acid, and the cover, G, tightly screwed on. When an electric pyrometer is



used, the wires are passed between the upper part of the cover, G, and the boiler, and connected with the poles of the battery, E. An ordinary thermometer is placed in the opening, F. As soon as the temperature of 212 deg. has been reached in the interior of the charge, the same will be indicated by the electric gong. A further penetration of steam for thirty minutes is

sufficient to sterilize every germ of infection. Before withdrawing the charge the boiler must be refilled, whereby the generation of steam is stopped, the cover, G, removed, and the articles, while still hot, shaken out or hung up in the air to dry. H is a cock for periodically emptying the boiler. This must never be done except when the latter is cold.

The following are the average results of over 100 trials: Contents of boiler, 20 gallons of water; temperature, 45 deg. to 50 deg. Fah.; steam generated in 25 minutes. The thermometer in steam outlet registered 212 deg. in 27 minutes. The electric gong, showing that a temperature of 212 deg. had been attained in the interior of the charge, rang in 38 minutes. The steam kept up for another 30 minutes. Total duration of trial, 68 minutes. Consumption of fuel, 7 lb. of firewood and 19 lb. of coal; by continuous disinfection, 7 lb. of coal per hour. Water evaporated, 5½ gallons, equal to 1,273 cubic feet of steam at 212 deg. Fah., or 32 cubic feet per minute. The maximum thermometers placed in different articles registered an average of 218 deg. Fah.—*The Engineer.*

SULFONAL, A NEW HYPNOTIC.

By EDMUND CHARLES WENDT, M.D., Visiting Physician St. Joseph's Asylum; Curator and Pathologist of the St. Francis Hospital and of the New York Infant Asylum, etc.

AMONG the class of so-called "troublesome" affections, insomnia is entitled to a foremost place. If medical statistics are to be trusted, idiopathic sleeplessness is certainly on the increase all the world over. And perhaps this is true to a larger extent in our own country than anywhere else. So long as the pathology of the condition in question, if it has a pathology, is so little understood, we must be content to deal with it in an empirical way. For neither the assumption of cerebral anæmia, nor of cerebral plethora, nor of any other single morbid state, will suffice to explain many of those cases that prove alike troublesome to the practitioner, to the patient, and to his family.

These facts have for some time been so clearly understood, that earnest and persevering researches have been undertaken, with the view of finding some remedy that would meet the symptomatic indications of the disorder, without possessing, at the same time, properties that involved actual or potential danger. It is, unfortunately, only too true that our best known narcotics are potent for mischief in both directions. Baneful habits are encouraged by their unstinted employment, and in more moderate dosage they fail to afford the desired relief.

Thus it has happened that within the past few years a number of new remedies have been introduced, the action of which, we have been told, was unlike opium, chloral, cannabis, or the bromides. Most of these drugs belong to the acetal group of compounds. They include methylal, acetophenon (better known as hypnon), urethan, paraldehyd, and hydrate of amylen. The two last named have found some favor at the hands of the profession, although none of the remedies named has proved uniformly satisfactory.

The most recent drug of this kind comes to us with the indorsement of eminent German authority. But it comes to us unheralded by the usual exaggerated accounts of hitherto unheard of efficacy and universal applicability. According to Professor Kast,* of Freiburg, sulfonal is a hypnotic pure and simple. It does not compel sleep through a paralytic effect on the nerve centers, nor through a profound impression produced upon the vascular system. From numerous experiments on animals, and many clinical observations on man, the action of this new remedy would appear to consist merely in the intensification of those factors that lead to natural sleep in the physiological sense, or in supplying the periodical desire for sleep in those cases where it is wanting. It is for this reason, probably, that the range of applicability of sulfonal is a more limited one than that of some other drugs employed as hypnotics.

But sulfonal, we are informed, has none of the disadvantages inherent in the deadly narcotics, and it is much more reliable than any of the bromides. This new body does not disturb digestion, it is not constipating, it has no unpleasant after-effects, it is perfectly harmless, it does not invite the formation of "a habit," and, finally, it does not appear to lose its efficacy, even when employed for a long period. Surely this is enough to recommend sulfonal to our attention, and if the profession will confirm the claims put forth by its sponsors, there can be no doubt that an extremely valuable addition will have been made to our stock of remedies.

Sulfonal was first prepared by Baumann,† formerly assistant to Hoppe-Seyler, and well known for his numerous researches concerning organic compounds. It would appear that, like so many of our newer drugs, this body was found only partly in consequence of a definitely understood purpose, and in part as the result of accident.

Professors Kast and Baumann had been engaged in investigating a series of bodies known as disulfones. Almost the first substance submitted to a more detailed analysis and examination was the product of oxidation of a compound, resulting from the action of acetone or æthylmercaptan. It was this body that later was found to be the valuable hypnotic under consideration.

Chemically, this substance enjoys the euphonious designation of "diæthylsulfondimethylmethan." We fully concur in the opinion expressed by Professor Kast, that "sulfonal" is a more comfortable name. The formula of the new drug is $(CH_3)_2 = C = (SO_2C_2H_5)_2$. It occurs in the form of large flat, colorless crystals, which are tasteless and devoid of smell. Sulfonal is soluble in 18 to 20 parts of boiling water. In tepid water the solubility is only about 1 to 100. The crystals dissolve more readily in alcohol and alcohol mixed with ether. Acids and alkalies do not affect the composition of the body, which appears to possess considerable chemical stability. The crystals melt at a temperature of 257° to 260° F.

As regards dosage, we learn that fifteen to sixty grains usually suffice to insure several hours of refreshing sleep. The hypnotic effect is observed from half an hour to two hours after the exhibition of the drug. It is best administered mixed with a little water, or in wafers or capsules. An average dose to begin with is fifteen grains.

It appears that sulfonal is specially applicable to the simple insomnia so often witnessed in neurotics. But it has also been found useful in febrile wakefulness, in the restlessness of organic heart disease, and even in the delirium of dementia.

Sulfonal has already been largely employed in the treatment of mental disorders. Dr. Rabbas,* of the Marburg Lunatic Asylum, has published a special report in which he speaks very highly of this new remedy. He has used it over two hundred times, with uniformly gratifying results. He emphasizes particularly its absolute harmlessness, which contrasts favorably with the greater or less danger of the hypnotics hitherto usually employed in lunacy practice.

The best time to administer sulfonal would appear to be the late afternoon and evening hours. From five to eight, or even ten, hours of profound sleep usually follow its use. Women are more readily influenced by the drug than men, and fifteen grains is generally sufficient to put them to sleep.

Professor Kast believes that sulfonal affects the gray matter of the brain, but in what way he does not state. From carefully conducted microscopical and spectroscopical examinations, it is asserted that this substance has no ill effect on the blood. This holds good even in the case of animals actually poisoned by its use. The mucous membrane of the alimentary canal likewise remains unaffected by its internal administration.

I have not hitherto been able to obtain the drug in this city, and I have, consequently, no personal experience concerning its efficacy.

Through the kindness of my friend Dr. Kammerer, of New York, I am able to state that a supply of this drug, sufficient for clinical trials, has already been shipped by Professor Kast to him, and is daily expected by us.†

I have not hesitated to give to the readers of the *Medical Record* early information regarding sulfonal, because it has the indorsement of gentlemen whose professional standing offers a guarantee of the trustworthiness of their assertions. It goes without saying that we will require the confirmatory evidence of the profession at large before we can state positively that, in the discovery of sulfonal, we have really found the much sought for desideratum, namely, a safe, unfailing, and yet powerful hypnotic.—*Medical Record.*

* Sulfonal, ein neues Schlafmittel. Von Prof. A. Kast, in Freiburg i. B. Separat Abdruck aus Berliner klin. Woch., No. 16, 1888.

† Ber. der deutschen chem. Gesel., vol. xix.

SULFONAL.

THE appearance of sulfonal as a hypnotic (see before, April 28, p. 901) has been quickly followed by the publication of a test for its recognition. Dr. Vulpius recommends for this purpose (*Pharm. Centralh.*, May 17, p. 245) the regeneration of mercaptan—of which the compound is a condensation product—by fusing a decigramme of sulfonal with an equal weight of potassium cyanide, when a thick vapor is at once given off, having the unbearable odor of mercaptan in a high degree. Herr Ritsert, however, objects to the use of potassium cyanide, and proposes pyrogallic or gallic acid as a non-poisonous substitute (*Pharm. Zeit.*, May 21, p. 312). Herr Ritsert heats one or two decigrammes of sulfonal in a dry test tube until, at about 280° C., the water-clear fused mass begins to give off bubbles of gas. From 0·05 to 0·1 gramme of pyrogallic or gallic acid is then added, which causes the clear liquid to become brown and evolve the characteristic mercaptan vapor. As to the probability that sulfonal will take permanent rank as a hypnotic, Mr. T. E. Lovegrove, writing to the *British Medical Journal* (May 26, p. 1113), says that his experience with it has been very discouraging. For several hours after the drug had been taken no appreciable effect could be observed in the patients, but during the greater part of the following day there was extreme drowsiness and considerable cyanosis. He found it to require for solution considerably more than "eighteen to twenty parts of boiling water," and immediately on cooling it crystallized out; neither was it soluble in one hundred parts of water at the ordinary temperature. Mr. Lovegrove considers the best mode of administering sulfonal is to mix it with pulv. tragacanthæ co. and water. According to Dr. Scholvien (*Pharm. Zeit.*, May 30, p. 320), one part of sulfonal requires for solution 15 parts of boiling water, 500 parts of water at 15° C., 133 parts of ether at 15° C., 2 parts of boiling alcohol, 65 parts of alcohol at 15° C., or 110 parts of 50 per cent. alcohol at 15° C. After recrystallization of commercial sulfonal three times from 50 per cent. alcohol, absolute alcohol, ether, chloroform, and benzol, the melting point proved to be uniformly at 125·5° C., and Dr. Scholvien thinks therefore that this character may be taken as an indication of a pure product. Dr. Kast, who introduced sulfonal, reports that he has found an allied disulphone, ethylidendiethylsulphone, to act as a narcotic in the same doses as sulfonal, and probably in less time, but it appears to produce disturbance of the heart's action. A number of other disulphones have been experimented with, but proved to be inactive or objectionable on account of the symptoms produced.—*Pharmaceutical Journal.*

* Ueber die Wirkung des Sulfonals, von Dr. J. Rabbas. Separat Abdruck aus Berlin. klin. Woch., No. 17, 1888.

† The druggists Eimer & Amend have, at my suggestion, also ordered an adequate supply of the drug from the German manufacturers, Fr. Bayer & Co., in Elberfeld.

POPULAR BEVERAGES.

By P. L. SIMMONDS.

IN all countries, civilized and savage, men exert their ingenuity to concoct some popular beverage, either as a thirst quencher or an intoxicant. The indigenous vegetable products suitable for the purpose are made available, whether they be grains, fruits, roots, or the sap of trees. Some of these beverages are moderately pleasant, others inebriating; but, as the temperance advocates have found after numerous experiments, it is extremely difficult to obtain any palatable, refreshing drink without a small portion of alcohol forming part of its constituents. A brief glance at some of the less known national drinks may not be without some interest. The indigenous manufacture and consumption depends much on the supply of the raw material from which it is locally produced, although in rich and civilized countries extraneous supplies of popular beverages are imported, where they cannot be made locally in sufficient quantity.

In some localities cider is popular and cheap. The percentage of alcohol in cider ranges from 5½ to 9.

The production of cider varies in France considerably year by year, and sometimes it falls as low as 4,000,000 or 5,000,000 hectoliters, while in other years it reaches 17,000,000 or 18,000,000. It is principally consumed locally in the country districts, and very little is exported.

The best cider is said to be made in the Province of Normandy, where it was introduced many ages since by the Moors, but cider is made in no fewer than 54 departments. About 150,000 barrels of cider and perry are annually made in the western counties of England, the sweet in Hereford and the rough in Devon, and a good deal is also made in North America. In the Dominion of Canada about 1,000,000 gallons of cider are drank yearly. In Chili, after making cider and wine from their apples, they extract from the refuse a white and finely-flavored spirit, and by another process they procure a sweet treacle, or, as they term it, honey. When properly fermented and prepared, the black mulberry yields a pleasant vinous liquor. In the cider counties of England mulberries are sometimes mixed with apples to form a beverage known as mulberry cider.

The fishermen of Newfoundland, Labrador, and the Gulf of St. Lawrence drink large quantities of spruce beer; it is considered an admirable corrective of their diet, which consists principally of fat pork and salt fish. The process of making it is simple. A few black spruce branches are chopped into small pieces and put into a pot containing six or eight gallons of water, and boiled for several hours. The liquor is then strained and put into a cask that will contain eighteen gallons. Molasses is added in the proportion of one gallon to eighteen gallons. A pint of the grounds of the last brewing and a few hops, if at hand, are also put in, and the cask, filled up with cold water, is left to ferment; in twenty-four hours it becomes fit for use. Spirits are frequently mixed with spruce beer to make the drink called "callibogus." In New Zealand a drink somewhat resembling spruce is made from the twigs of *Dacrydium taxifolium*, and was used by Captain Cook.

From the sap of the birch tree some of the tribes of Northern Russia prepare their ordinary drink, "birkenwasser," from which they also make vinegar; and in some districts they boil it into a sweet sirup, which serves them instead of sugar. For those who are too poor to drink beer or mead, this northern wine is the only potive drink.

A drink delightfully acid and refreshing is made in Brazil from the pulp of the capsule which envelopes the seed of *Cacao theobroma*.

The saccharine liquor extracted from the unexpanded flowers of the Ita palm of British Guiana is said to afford a liquor resembling champagne in its briskness.

The sap of the Sontar palm (*Borassus flabelliformis*) is obtained from the stems of the bunches of fruit when cut. This liquor is drunk either fresh or after it has undergone a light fermentation. It bears also the name of towak or palm wine. Sometimes a species of *Strychnos* is infused with it, which produces a stupefying and intoxicant beverage sold daily in the bazars in the Moluccas, especially at Amboyna, in sections of bamboo. Palm wines are common in most warm climates. In the Eastern Archipelago it is obtained from the gomuti palm (*Arenga saccharifera*). The principal production of this palm is toddy (from the Sanskrit *tâde*), which is obtained in the following manner: One of the spadices is, on the first appearance of the fruit, beaten on three successive days with a small stick, with the view of determining the sap to the wounded part. The spadix is then cut a little way from its root (base), and the liquor which pours out is received in pots of earthenware and sections of bamboo or other vessels. When newly drawn the liquor is clear, and in taste resembles fresh must. In a very short time it becomes turbid, whitish, and somewhat acid, and quickly runs into the vinous fermentation, acquiring an intoxicating quality. In this state great quantities are consumed.

In Ceylon, Madras, and other parts of India, toddy is obtained from the sap of the palmyra palm (*Borassus flabelliformis*), and there are two kinds, the unfermented juice called sweet toddy, and the fermented or "culloo." The sap of *Caryota urens* is also drunk. The sap of the wine palm (*Raphia vinifera*), called "bourdon" and "lope," is much relished by the savage tribes of West Africa. Other of their favorite inebriants are "wawa," or plantain wine, and "bombe," small beer made of grain. The latter is served in neatly carved and colored gourds, and the contents are imbibed, like sherry cobbler, through a reed. The cool, refreshing milk of the cocoanut is highly esteemed, and other palms are brought into requisition for beverages, such as *Phœnix dactylifera*, and *Sylvestris*. *Attalea cohune*, *Elais guineensis*, and *Jubea spectabilis*.

In Siam, China, and Japan, rice is the principal grain used for distilling, and forms the "lan" of Siam, the "shonchou" and "mandarin" wine of China, the "saké" of Japan, and the "badek" and "brom" of Java.

In China the rice wine they use is by no means agreeable. It is always taken hot, and somewhat resembles Madeira in color and taste.

The Malays have a fermented liquor made from rice which they call "gelang."

The Javanese beverage "brom" is prepared from the fermentation of rice, and is a kind of beer, and not the produce of distillation. The fine arrack (a name derived from "*arak*," Arabic for ardent spirit) is an invention and manufacture of the Chinese, of which the materials are boiled rice, molasses, and palm wine.

Saké, or rice beer, is the principal and almost the only alcoholic beverage of Japan. The production is estimated at about 150,000,000 gallons annually, equal to about 4½ gallons per head. Until the last two or three centuries saké was not manufactured on a large scale, but each household made its own supply. Now there are very large breweries in different parts of the country. There are a great many varieties of saké to be obtained in commerce, differing somewhat in taste, flavor, and price, and distinguished by fancy names. The proportion of alcohol in saké varies from 5 to 15 per cent. The "saké" of Japan is very heating and heavy, and appears to be as vinous in quality and strength as European ale or beer. It is flavored with honey or sugar.

The Indians of Chili make a drink of maize. The

grain is first baked, then steeped in water for a certain time, after which it is boiled and set by to settle, and when fined is fit to drink.

Indian corn is largely used for distillation all over North America, and in South America it appears to have been made into "chica," or maize beer, at a very remote period, for it was a common drink of the Indians long before the Spanish conquest. The liquor is said to be of a dark yellow color, with an agreeable slightly bitter taste. It is in universal demand on the west coast of South America, and is consumed in vast quantities by the mountain Indians. Scarcely a single hut in the interior is without a jar of this favorite liquor. From the stalks of the maize a beverage is also obtained in Mexico.

In some of the River Plate States the inhabitants make a liquor from the sweet pods of the algarrobo (*Prosopis alba*) which, when new, is refreshing, but becomes alcoholized after fermentation. In some districts this liquor is the principal attraction at social meetings.

Sir Joseph Hooker tells us how Murwa beer is made in the Himalayas. Millet seed is moistened and fermented for two days. Sufficient for a day's allowance is then put into a vessel of wicker work, lined with India-rubber to make it water-tight, and boiling water is poured on with a ladle of gourd from a huge iron caldron that stands all day over the fire. The fluid, when quite fresh, tastes like negus of Cape sherry, rather sour.

In some parts of the East, a fiery, intoxicating beverage is made of jaggery (sugar), bhang (hemp), poppy seeds, pepper, cardamoms, and nutmeg.

The fermented fruit of the peach gives an excellent brandy, which is chiefly manufactured in the United States. In the southern parts of Hungary the well-known liquor "shivowitza" is made from the shiva plum.

The liquor called "maraschino," which is chiefly manufactured in the Italian States and Dalmatia, is prepared from a variety of cherry. The fruit and seed are crushed together, one part of honey to the hundred added, and the whole mass subjected to fermentation; during this process it is distilled. The kernel of the cherry contains the elements of hydrocyanic acid, and is accordingly much used for communicating its peculiar flavor to brandy and liqueurs.

From the succulent peduncle of the cashew nut (*Anacardium occidentale*) an excellent spirit has been distilled with diuretic properties, similar to the best hollands. A wine made from it resembles in taste an ordinary claret sweetened with sugar, and is a popular beverage among the poorer people in South America. It is the custom of the Brazilians to suck a cashew before breakfast, but at any hour of the day the juice is delightful. It is sweet and delicious, slightly astringent, and a wonderful allayer of thirst. The juice of one cashew is more grateful to a thirsty person than a goblet of the purest water.

The Australian aborigines obtain a fermented liquor by soaking the seed vessels of the *Pandanus*, and washing out the sweet, mealy substance contained in the lower part between the fibers.

The national drink of the Mexicans is "pulque," the sap of the maguey or American agave. After expressing the juice between rollers, or, as was formerly done, by means of suction, it is carried to vats (which are made of raw hides) for fermentation. The sap, which resembles cider, and has a very disagreeable smell, taken alone or diluted with water, is a common sweet beverage in use in Mexico. When fermented this liquor is very intoxicating, containing about 36 per cent. of absolute alcohol. To strangers both the taste and smell are horrible, something of the style of rotten eggs, but people seem to get accustomed to the flavor. Bayard Taylor says: "I can only liken the taste of this beverage to a distillation of sour milk (if there can be such a thing), strongly tinctured with cayenne and hartshorn."

A pleasant beverage, called "chica de mirtilla," is obtained in Chili from a species of myrtle berries (*Mauria simplicifolia*). These are about the size of a large pea, of a deep red color, and of a peculiarly sweet and delicious aromatic flavor. They are prepared by crushing them in water, and allowing them to ferment for a few days. The black cluster berries of the molle tree are also gathered for this purpose by the Indians. They have a combined flavor of juniper and pepper.

Chica is also made from the saccharine liquors of the algarrobo or carob tree (*ceratonia siliqua*), by merely infusing them in water, straining, and allowing the infusion to ferment. At the expiration of three or four days it is very palatable, and if proper attention were paid to it, a very delicate wine might be obtained.

Masato is another South American drink, made either from ripe plantains or yucca (*cassava*) roots boiled till they are quite soft. These are reduced to a pulp by beating them in a trough; this pulp is then put into a basket lined with leaves, and allowed to ferment for two or three days. When it is wanted for use, a spoonful or more is taken out and put into a totuma or calabash, bored full of holes like a cullender. A quantity of water is added to it, and the whole is rubbed through the holes of one gourd into another without holes, which serves as a bowl to drink out of, or small totumas are filled from it and handed round. Stevenson, who describes the preparation in his "Travels in South America," says he was highly pleased with the drink, and scarcely took anything else for his breakfast. The taste is a sub-acid, but remarkably agreeable.

The sap of the *Bromelia pinguin*, when properly prepared and allowed to ferment, makes a pleasant drink, which is considered little inferior to champagne.

Mention has already been made of the succulent peduncle of the cashew nut, from which an excellent spirit has been distilled, with diuretic properties similar to the best hollands. The fruit roasted when ripe, and added in slices to punch, communicates an agreeable flavor to it, and if the punch thus prepared be bottled, it soon ferments and thus becomes a delicious, sparkling liquor. Advantage has been taken of this readiness to run into the vinous fermentation to manufacture an excellent wine from this fruit. Mr. J. H. Tobin, of Nevis, some years ago devoted much time to experiments on its manufacture. The following was his recipe: Mix two parts of the expressed juice with one part of water, putting to every gallon of juice 3½ lb. of the best sugar, and to every gallon of water 4 lb., and adding six gills of lime juice for every 8 lb. of sugar. Bung the cask down tight before the fermentation has wholly subsided, and fine in the usual way with eggs.

According to Bridge's "Annals of Jamaica," cassava formed the component part of the principal beverage of the Indians of the West India islands, and was much used also by the Spaniards. It was called "ouycou," and was thus made: A large earthen vessel was nearly filled with 60 quarts of water, into which two cassava roots (*Janipha manihot*) were broken, with a dozen sweet potatoes (*Batatas edulis*), four quarts of sugar cane juice, and twelve ripe bananas. The vessel was closed and the mixture left to ferment two or three days, when, the scum being removed, the clear liquor was ready for use. It is said to have been strong and refreshing, but was surpassed by the "mabey," a species of Indian beverage more resembling wine, and which a French author affirms was "un vin claret, aussi fin que le meilleur Poire du Normandie." It was thus made: Into thirty quarts of water are put two of clarified sirup, twelve red sweet potatoes, and as many oranges cut into quarters. The mixture is then allowed to ferment about thirty hours.

Nature, very far from having, as is generally thought, deprived the torrid zone of fruits adapted to the production of an agreeable vinous drink, capable of alleviating the heat which is felt by the inhabitants of those burning countries, has enriched it with the cane, which presents in its sugar the purest aliment, and in its fermented juice the most abundant source of a wholesome drink. The cane lends itself to every taste; like the apple or grape, it is made optionally to yield cider, wine, or brandy.

A Dr. Dutrone, of San Domingo, published in the close of the last century, some essays giving information as to wine he made from the juice of the cane. "Having observed in Normandy (he says) that in order to obtain good cider from different kinds of apples, it was necessary to leave them in a garret for a certain time, accordingly I left the canes to themselves, and after eight or ten days they assumed the same vinous smell of apples. I had them pressed. The already far advanced spirituous fermentation continued in the juice expressed, and in five or six days I obtained a wine perfectly analogous to cider." It must be strained and drawn off after twenty-four hours' settling. In this state the wine is too sweet for use as an ordinary drink; it is, therefore, advisable to leave it alone for some time, as is done with cider. If immediately bottled it will, in a short time, sparkle and pop like champagne. Its color is more or less of the amber, according to the state and quality of the canes. By adding to the must the juice of some fruit, say of the pineapple, orange, lime, guava, or the mammy sapota, a wine is obtained possessing the aroma and flavor of the fruit employed. It may also be colored red with the juice of the prickly pear fruit. A fermented liquor called cariacou is made in Cayenne from a mixture of cassava, sweet potatoes, and cane juice.

In Brazil and the West Indies wine is made from oranges. The fruits are collected and exposed to the sun for three or four days. They are then cut into slices without being peeled, and the juice squeezed out by twisting; the cloth in which the slices are placed is left undisturbed for twenty-four hours. The essential oil which swims on the top is skimmed off with a spoon or absorbed with a plug of cotton. To every 25 lb. of liquid is added brandy 18 degrees over proof and 12 lb. of sirup of sugar. This mixture, thoroughly stirred up, is put into jars or pots, which are covered up with wood and lime, and buried two feet in the ground. At the end of two months the wine is fit to drink, but its quality, like that of most wines, improves with age.

In Brazil, wines have also been made from the pine-apple, from the jabuticaba (*Eugenia cauliflora*), and from the *Passiflora quadrangularis*, which have been taken for Spanish wines.

Coffee berries and bananas likewise afford an excellent spirit. By fermenting tamarinds with a portion of sugar, a good wine may be obtained. Plantain wine is an extremely palatable and wholesome drink, obtained after steeping the ripe fruit, and allowing it to ferment for twenty-four hours.

In Mexico an alcoholic drink known as sotol is obtained from the sap of a bromelaceous plant (*Dasylirion texanum*). This plant sometimes covers many square miles of arid, stony slopes. The base of its leaves and young stems are full of a sweet, refreshing, and nourishing saccharine matter. It is from these, after a process of boiling and fermenting, that the alcoholic liquor is distilled, and from one large basal part of the leaf nearly a pint of this is to be procured. It is limpid and colorless, with a peculiar penetrative odor, and a taste which, though a little bitter, has been compared to the smoky flavor of Scotch whisky. It is largely consumed locally, and seems to have little deleterious effect on the human system. The Mexican barrel of sotol, containing about 28 gallons, is sold at 15 dollars, and the liquor is retailed at from 30 to 40 cents (15d. to 20d.) a quart.

An agreeable vinous liquor made from honey was formerly in much repute in this country, and is still popular in Africa and other parts. The use of this substance as one of the ingredients in drink is of very ancient date. When fermented, honey water obtains the name of mead, or metheglin, which is in fact honey wine; indeed, the Germans call it by that name. Mead is said to have been the principal beverage of the Britons before the use of malt liquor, and even long after the introduction of beer, mead was a favorite drink. Queen Elizabeth was so fond of mead as to have had it made every year for her. Mead formed the drink of the Scandinavians, and was celebrated by their bards. Primrose blossoms were used by them to flavor it.

The manufacture of tedge, or honey wine, in Abyssinia, is a royal monopoly. It is not publicly sold, but there is a kind of conventional license (not exactly smuggling), by which, for double or treble its value, this beverage may be obtained. The process of preparing this liquor is very simple. Cold water being poured over a few small drinking-hornfuls of honey placed in a jar, is well stirred up; to this is added a handful of sprouted barley (*biecalo*) scorched over the fire and ground into a coarse meal, with the same quantity of the leaves of the gaisbo, a species of rhamnus, which, when powdered, yield an intense but transient bitter, like gentian or hops. The mixture, being allowed to stand for three or four days, ferments, and is generally drunk in that state, but is then rather a curious kind of muddy beverage, full of little flocculent pieces of wax. It is more agreeable, but not unlike in appearance or character very strong sweet wort. To a superior kind made for the king's own table, besides the bicalo and gaisho is also added a kind of berry called *kutoh*, which grows not unlike the fruit of our elderberry, and may possibly be the production of some tree belonging to that species. The jars containing this are sealed with a large cake of clay, mixed with the lees of the decanted liquor. This kind of tedge is allowed to stand for several months before it is used, and is called "barilla." It is handed to guests in small Venetian bottles of green glass, the fracture of one of which is a grievous offense, and the king always makes the careless party pay for it.

In Madagascar, too, they make a honey wine, a composition of three parts of water to one of honey, which they boil together, and skim, after it is reduced to three-fourths. They afterward put it to ferment in large pots of black earth. This wine has a pleasant tartish taste, but is too luscious.

The juice of the purple fleshy petals of the *Coriaria ruscifolia* affords a grateful beverage to the Maories, and a wine like elderberry wine used to be made from it by the missionaries.

In parts of Southern Africa the natives make two different kinds of liquor, one called "epeakla," and the other "wocahnyeye." The first is prepared in the following manner: A large quantity of maize with a proportion of water is put into a wooden mortar, pounded for half an hour, and afterward placed in the shade to ferment. At the end of two days it is boiled, and when cold a small decoction of millet well pounded is added, and the whole after standing a few hours strained through a meal bag, from which the liquor oozes perfectly pure, and of a milk-white color. In one day it is drinkable, the next sour, and less than two bottles will occasion inebriation. The second named liquor is obtained from the *mancanyeye*, a fruit resembling the guava. A small hole is cut in the fruit through which the juice is squeezed into a large boiler, where, after having stood some time over the fire, it remains to ferment until the next day. More juice is then added, and the same operations repeated. It then becomes drinkable, and will continue so for three days. It has scarcely any color, but a sweet and pleasant taste, and is not of so intoxicating a nature as the other native beer.

The Basutos make a beer in this manner: The grain is left to sprout, when it is ground and enough boiling water poured upon it to make a paste. When cold, water and yeast are added, and when it has fermented for two or three days the liquid is placed on the fire and boiled several times to strengthen it. For the same purpose they add a few handfuls of fresh flour, when it is afterward strained.

Passing to India, we find that the tribes of the Western Ghats make an intoxicating drink called "barr" from the milky sap of the mudar (*Calatropis gigantea*). In Goa a wine very fairly resembling port is prepared from the fruit of *Eugenia jambolana*. The Santals are said to use *Ruellia suffruticosa* when they wish to prepare a pleasant beverage from rice, but add *Clerodendrum serratum* to make this intoxicating.

A spirit is distilled from the saccharine flowers of the mohwa (*Bassia latifolia*) and also from the seeds. It is much like Irish whisky, having a strong smoky and rather fetid odor, the latter disappearing with age. This spirit is in popular repute among the natives (especially the Parsees) in Western India.

A poor kind of beer called "quass" is made in Russia from rye; it much resembles what is known as treacle beer. Another Russian popular beverage is "buhsa," prepared with millet and water, and occasionally mares' milk. After being bottled it ferments, and becomes effervescent. The taste is tart, with an unpleasant after-gout, and it is very intoxicating. Hydromel, a fermented mixture of honey and water, is not unlike rather flat ginger beer.

From the fruit of the merisier, or wild cherry, there is obtained by distillation a liquor much appreciated, known under the name of "kirschwasser." The mashed cherries are fermented with their kernels; this liquor is made in Germany, Switzerland, the Vosges, and the Duchy of Baden. The best, however, comes from the Black Forest.

The common beverage of the native tribes of the wilds of Tartary is "koumiss," made from mares' milk, the use of which has now spread over Europe and America. It has been commended as a refreshing and wholesome drink for general use. Chemical research and experience have established the fact that cows' milk makes an equally good koumiss. It is a white liquid, more effervescent than champagne, with a slightly acidulous, sweetish taste, somewhat like that of butter-milk, and leaving a fresh, very agreeable after taste.

In some of the Pacific islands an intoxicating beverage is obtained by the natives from the root of *Piper methisticum*, or *inebrians*, and called "kava." The manufacture is not a pleasant one, the dry root being masticated, and placed in a large bowl, on which water is poured, and the whole is squeezed and macerated by hand till the juice is expressed, which is handed round to the company. In the Fiji court of the late Colonial Exhibition an attempt was made to introduce kava here, but this was a distilled spirit, very different to the native kava.

The Egyptians have many sherbets or cooling drinks besides lemonade. A sherbet is prepared from mulberries, another from sorrel; one is made from raisins, one from a strong infusion of licorice root, and another from the sweet pods of the locust or carob tree. The most esteemed is prepared from a hard conserve of violets, made by pounding the flowers, and then boiling them with sugar. The violet sherbet is of a green color.

The question of cooling summer drinks in the sultry weather lately experienced is one of importance to large numbers. The refreshing influence of acids is well known. From the number of acids which is found in nature, and the tendency of many artificial substances to become sour, it is evident that acids and sours are essential to our life and well being.

The degree of acid employed to drink will necessarily be largely a matter of taste. Many will find relief from a beverage composed of diluted and unsweetened lemon or lime juice or rough Hereford cider with an equal part of any pure form of effervescing water.—*Jour. Soc. Arts.*

THE FRENCH TORPEDO CRUISER CONDOR.

AMONG the ships that are at present anchored in the roadstead of Barcelona, the Condor will certainly be one of the most remarked, at least by seafaring men. The public will indeed be struck by the imposing spectacle offered by the French, Italian, and Austrian ironclads that have come to do honor to Spain, but these are of known types whose fighting qualities have in a measure been tested. The attention of naval men is turned at present rather to ships of medium tonnage, designed to do battle with both torpedo boats and ships of heavy tonnage such as ironclads.

In order to fulfill this double mission it required, in fact, manageable vessels having a speed analogous to that of torpedo boats and capable of remaining at sea better than they, in a state to give or refuse battle, maneuvering easily, armed with torpedoes against ironclads, and with rapid-firing guns against torpedo boats, in a word, a sort of ship to do everything, despite its slight displacement.

It was of such an idea that was begotten, first, the Bombe, of 304 tons, and afterward the Condor, which better realizes the object proposed, and which gauges 1,272 tons. We now have four specimens of this type, for the Epervier, which at present forms part of the Channel squadron, the Vautour and the Faucon, which are not yet entirely finished, are absolutely like the Condor, at least in their essential characters.

These ships measure 223 feet in length and 29 in width amidship, and have a draught of 15 feet.

As for defensive power, the hull has an armored deck of steel extending from stem to stern. This deck is situated a little beneath the float-water line and protects the vital parts—engines, boilers, rudder apparatus, etc. Besides, the hull is divided into ten water-tight compartments by longitudinal and transverse partitions that extend up to the deck.

As for offensive power, the Condor has five four-inch guns, five torpedo tubes, and six revolving guns.

The motive apparatus, which is of 3,200 indicated h. p., consists of two directly connected compound engines.

We must add, for the greatest honor of our engineers, that the plans of the Condor are the first that were made to respond to the programme that we have given above. It is under their inspiration that the Scout type was created in England—a type that made so much stir on the other side of the Channel. Better still, it has been found that our Condor is superior, as regards speed, to the similar torpedo cruisers built by our neighbors. Thus, the English cruiser Cossack makes but 17·7 knots, while the Condor easily makes 18·5—a fact so much the more remarkable in that the first gauges nearly 400 tons more than the second.

To-day, the Condor has been experimented with sufficiently to permit of judging definitely of the services that she is capable of rendering, and it has been found that she can easily keep up a mean speed of 17 knots. This is a splendid result. The vessel is commanded by Captain Lormier.—*L'Illustration.*

GREAT bell at Cologne Cathedral, presented by the German Emperor in 1876, weighs 60,480 pounds, the clapper alone weighing 1,200. It was made of cannon captured in the Franco-German war.

THE SUPPORTING POWER OF SOILS.

By RANDELL HUNT, Member of the Civil Engineers' Society of St. Paul.

[Read April 2, 1888.]

IT is often necessary for the engineer to prescribe a limit of load, per unit of surface, in designing foundations for structures resting upon soil. In the absence of the time and means to make actual tests of the soil, he must confine himself to an investigation of existing successful structures upon a soil as nearly similar to the one under consideration as he can find. It is the object of this paper, then, to present a few remarks upon the actual supporting power of soils as deduced from an investigation of the matter from our own observations and the recorded examples which have been accessible.

It is probably possible to devise a general mathematical formula which would be applicable to the supporting power of any soil, but such an expression would necessitate our knowing so many particulars as to the character of the soil, such as its weight and natural slope, that we could judge of its actual strength fully as well without applying it. At any rate, we shall confine ourselves to-night simply to the practical side of the matter.

The Supporting Power of Clay.—The supporting power of clay is very variable and depends in a large measure upon the variety and upon its degree of saturation with moisture. In the roadbed of railroads, when the "surfacing" has been done with clay, a smooth, hard bed, unyielding and with far greater supporting power than would be required, is always found in dry weather. It becomes very compact, so much so that it is impossible to press the point of a walking cane into it. But after a drenching rain, all conditions change, and the roadbed becomes a mass of mud, into which the ties are pressed down and the clay bulges up between them.

We mention this simple example of dry and wet clay because it is familiar to most of us, and shows clearly the effect of too much moisture in such soils.

The clays vary considerably, however, in their chemical constituents, and are affected thereby in the degree to which they absorb moisture. Certain deposits are known to be compact and hard, with a high supporting power, while others are in the condition of a plastic material, easily compressed. But its chief characteristic, which renders all clay more or less unstable, when regarded in the light of a foundation, is its known property of retaining water once admitted to it, and its softening propensities, which gradually take place as the amount of water increases.

The stiff blue clay deposits of London are celebrated as much for the numerous failures of the bridges and other structures founded on it as for any other reason.

Old Westminster Bridge had probably about 5½ tons to the square foot of foundation, and failed.

Blackfriars' Bridge had about 5 tons and appeared to be stable for many years, but ultimately settled very badly.

New London Bridge was built in 1831 and founded upon piles, upon which as much as 80 tons per pile was imposed. Of course, it has settled—in some places as much as a foot. The pressure per square foot of the entire foundation of this bridge is 5 tons.

When the new Westminster Bridge was built the load per pile was reduced to about 12 tons, while the load per square foot of the entire foundation was reduced to 2 tons. I find no record of this bridge having shown any signs of settlement.

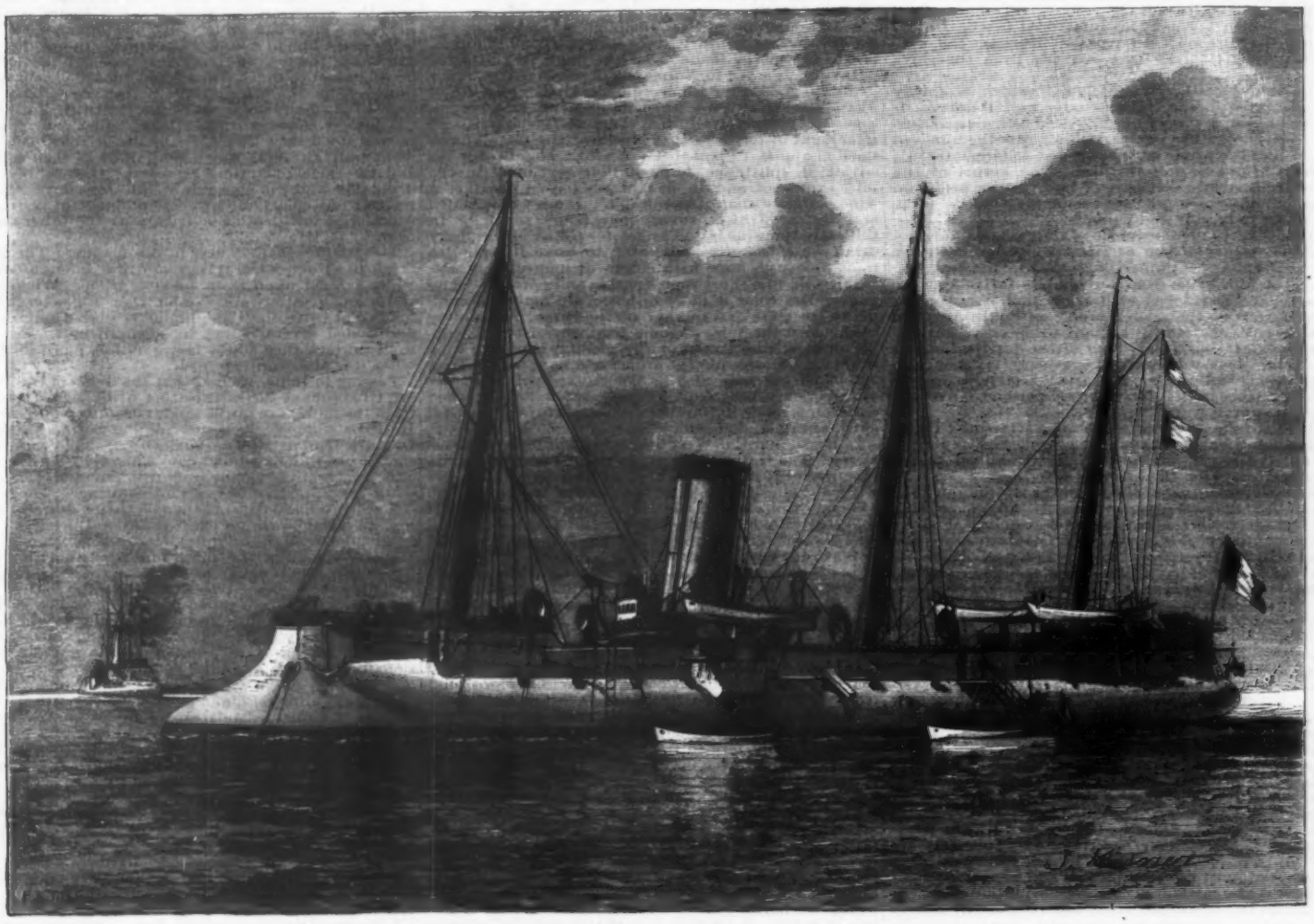
Robert Stevenson* attempted to load a stiff hard clay with 5 tons per square foot. He was building some high bridge piers at the time, but before they were completed serious settlements took place, and he decreased the amount per foot by making his foundation of greater area than first determined upon. He also built a large chimney which failed, and then constructed another, at Newcastle-on-Tyne, with only 1⅛ tons per square foot of foundation, which was successful. Both these chimneys are described as being founded on hard, compact clay.

The subsoil of the vast valley of the Red River of the North is a bed of clay, which varies in depth from 80 to 125 feet—a bed of sand and gravel usually being found underlying it. This clay is generally of a yellowish color, and appears more or less hard and firm in proportion to the amount of moisture contained in it. Chemically considered, it has a large amount of carbonate of lime in it, as can be seen from its action when treated with acids; and when freshly opened up to view in a place where free from much moisture, appears about of the consistency of marl.

In 1881, at Fargo, Dakota, a brick building, of four stories in height, including a basement story, was constructed upon a concrete foundation. The pressure per square foot upon the clay was at no place greater than 2½ tons, and was probably even less than this amount. The building showed a certain amount of settlement each season until, the third year after being built, one side of it suddenly commenced to crack, and settled a foot or more in a single day, becoming so dangerous that the occupants were compelled to abandon it. The side which had failed was immediately torn down, a new foundation of broader dimension put in, and the wall reconstructed. The load per square foot on the clay of the new wall is about 1½ tons, and, as far as the author knows, has remained intact. All along the side of the wall which failed was an open area, which was very imperfectly drained, and we are inclined to think was the cause of the clay becoming softer than it otherwise would have been, for the three other sides of the building, while showing more or less settlement, yet remained comparatively in good condition.

In the city of Cleveland, Ohio, many heavy structures have been founded upon clay deposits, and one or two notable ones have shown serious settlements. In the new Central Viaduct, now being constructed, and the foundations of which were described in the *Journal of Association of Engineering Societies*, the pressure per square foot of foundation on those piers and abutments which rest directly upon the clay has been limited to from 1 to 1·7 tons. The abutments, which exert the largest load mentioned are described as resting upon "a mixture of blue sand and clay, with some water," while the piers, giving a load of but 1 ton per square foot, rest upon a "plastic blue clay of various degrees of stiffness, mixed with fine sand."

* Trans. Am. Soc. C. E.



THE FRENCH TORPEDO CRUISER CONDOR.

EXAMPLES OF FOUNDATIONS ON SOILS.

(IN TONS OF 2,240 POUNDS.)

	Name of structure.	Date.	Engineer.	Kind of soil under foundation.	Pressure per sq. foot (tons).	
1	Central viaduct, Cleveland, Ohio	1887	C. G. Force.....	Blue clay.....	1·0 to 1·7	The blue clay of the foundation is mixed with some sand and water. (Jour. of Ass. of Eng. Soc., Vol. VI., No. 6.)
2	Bridge on R.R., Busigny to Herson, France.....	..	....	Unstable sand.....	1·8	Over the *Canal de la Sambre*. (Debauve.)
3	Arches on R.R., Busigny to Somain, France...	..	.....	Yellow sandy clay..	2·1 to 2·8	(Debauve.)
4	Chimney at Newcastle-on-Tyne..	..	R. Stevenson ...	Compact clay.....	1½	(Trans. Am. Soc. C. E., Vol. II., page 287.)
5	Kuilenb'g bridge, Holland.... ...	..	... .	Compact sand	2·3 to 2·9	A slight mixture of clay with the sand. (Debauve.)
6	Chimney N. Y. Steam Co.....	1882	C. E. Emery	Wet sand.....	4·0	Sand was not very compact; some slight settlement. (Tr. Am. So. C.E., Vol. 14, p. 180.)
7	Viaduct, Point-du-Jour, France	..	Bassompierre Sewrin	Coarse gravel.....	4·4	(Debauve.)
8	Brooklyn bridge (anchorage).....	1882	Roebling.....	Sand.....	4·0	
9	Brooklyn bridge, N. Y. Pier.....	1882	"	Compact stony clay.....	5·5	
10	Nantes bridge, France....	1868	.....	Sand.....	6·78	Some settlement has taken place. (Gaudard.)
11	Gorai bridge, Lock Ken Viaduct, Bordeaux bridge....	..	.....	Compact sand and gravel....	7·36 to 8·17	(Gaudard.)
12	Washington Monument.....	1884	U. S. Engineers..	Clay and sand.....	3 to 9	Slight settlement during construction. (H. R. Mis. Doc., No. 8, 48th Cong., 2d ses.)

When clay is mixed with other materials, as coarse sand and gravel, its supporting power usually largely increases, being greater in proportion as the other materials are in excess, up to the point of forming a concrete mass, in which the clay is the cementing material, and in just sufficient quantity to bind the materials together. In this condition we often find the clay in an indurated state, and the hardness of the mixture—commonly called "hard pan"—is proverbial. Such soils are safe for heavy loads, approximating that of the softer rocks.

Brennecke, in his book on foundations, mentions a large chimney with a load of 6 tons per square foot on hard clay. This is an extraordinary example, and we are inclined to think, though no further particulars are stated, that it was upon some such hard mixture of clay and gravel as mentioned. At any rate it would be a bad precedent to follow in loading beds of pure clay.

The Washington Monument is founded upon a layer of clay and sand. When the shaft was up 150 feet, an investigation showed that the foundation was entirely inadequate upon which to complete the structure—a committee of United States Army engineers reporting that such a soil should never be loaded above 10,000 pounds per square foot. The foundation was therefore made heavier and larger, and the shaft successfully completed with a height of 555 feet. Colonel Casey, the engineer in charge, reports the pressures upon the soil as nowhere exceeding nine tons per square foot, and less than three tons per square foot near the outer edges.

The settlement of the monument during the repairs to the old foundations was about two inches, and afterward a further settlement gradually occurred during construction of two inches more, making a total of four inches. If the load per square foot on the soil reaches the amount of nine tons, it is the heaviest load upon such a soil which we find any record of, and we think the doubts expressed by different persons as to the ultimate stability of the monument entitled to careful consideration.

Supporting Power of Sand.—Foundations on coarse sand and gravel are usually successful, particularly if free from the action of running water, and structures, proportioned in accordance with any ordinary rules of good construction, are hardly likely to have an area of base which will not be sufficient to limit the load per unit to the safe carrying capacity of the soil. Coarse sand deposited in beds has usually a high supporting power, but the coarseness alone is not proof positive of this, for it also depends somewhat upon how it has been deposited. On beds of sand made artificially, as is often done for foundations, the dry sand loosely thrown down does not form a compact mass such as is desirable, and a certain amount of compressibility will exist.

In some experiments made in France with river sand, it was found that by pounding the sand in thin layers its density could be increased one-fifth, and that there still remained about 20 per cent. of voids which could be notably reduced by simultaneously treating the sand with water while the stamping down took place. The compression was exercised in these experiments by means of hydraulic presses, and the result obtained that river sand treated as above would resist up to pressures of 1,420 lb. per square inch.

Water is the chief agent which makes the particles separate and draws them into the voids of the mass, and is invaluable in all works of embankment in which solidity is required; but it must also be well drained off, because if the original amount should remain, of course the mass of earth would continue in a semi-fluid state.

Mr. McDonald, in constructing the iron ocean pier at Coney Island,* assumed that the safe load per square foot upon the flanges of the iron disks, which were sunk into the sand, was five tons. But many of them really support as much as 6·3 tons continually, and are subject to occasional loads of eight tons per square foot, which they appeared to sustain without settlement.

The foundation of the large chimney of the New York Steam Company† was made of concrete resting directly on the sand of the old beach, which had formerly extended to this point. This sand was quite fine, with pockets of gravel, and containing at a few places some stone. The sand was thoroughly saturated with water, and would flow when disturbed or undermined. The load per square foot on this material was to be four tons, but before more than one-third of this amount was placed upon it, slight settlements occurred which were not uniform. After the structure was completed slight cracks appeared, but not sufficient to cause any material damage.

In contrast with the loading of the partly unstable sand of this chimney may be mentioned the loads which were imposed upon a clean, coarse sand in the foundations of the Pacific Mills chimney, at Lawrence, Mass. Here the sand was inclosed by tight sheet piling, and only 1·33 tons per square foot placed upon it.

The anchorage of the Brooklyn Bridge rests upon sand, with a pressure of about 4 tons per square foot. The Nantes Bridge, constructed in 1868, and founded on sand, has a pressure of 6·78 tons per square foot, but has settled somewhat.

The safe loading upon the sandy soil of Berlin is generally taken at abont 2·3 tons. Brennecke describes this sand as being comparatively loose, but likewise mentions its having been successfully loaded up to 4·1 tons per square foot.

When sand is mixed with other materials, such as clay or loam, which have the power of retaining water, its supporting power grows less, and proportionally more so as the sand becomes finer and loses its sharpness. Of such a nature is the commonly called "quick" sand, which really occupies a position between pure sand and pure clay, being a mixture of them both. Pure clay is composed of alumina, water, and silica, and in proportion as the silica is absent the more water will it hold. This is the material which, when mixed with the very fine and rounded grains of sand, makes it "quick." Deposits of such are often found, which through long draining have lost all the water, and which appear dry, and loose, and easy to excavate or handle, and generally of a whitish color.

If we could keep such deposits absolutely free from saturation with water, we could trust it with moderate loads. Its weight is less than either good sand or clay, running from seventy to ninety pounds per cubic foot.

At the foundations of the capitol at Albany, Mr. W. J. McAlpine describes some of the material as being quicksand without the water. Experiments made in the soil of this foundation showed that under a weight of two tons per foot no perceptible displacement occurred; and at about five tons the surrounding soil was forced upward. It was endeavored to place no more than two tons per foot upon the soil with the completed building, and great pains were taken, by means of spreading gravel six inches deep over the whole area, and inclosing it in a puddled wall, to keep the character of the soil from changing. These foundations have partly failed, and serious cracks have appeared in different parts of the structure. We wish here to call your attention to the remarks which we shall make later on, upon judging of the supporting power of soils by limited experiments upon the same. We have not been able to find any complete account of how they were made in this case.

We find recorded by Debauve a case of founding upon a loose, watery sand, partaking somewhat of the nature of quicksand, in which the load per square foot was 1·8 tons. The sand is described as being of a sirupy consistency, and after endeavoring to excavate it without success, further than getting out about three feet in depth, they filled back into this partially excavated hole with dry, coarse sand, placed a bed of beton upon it, and completed the structure, which was a bridge over the canal of the Sambre à l'Oise, for the railroad from Busigny to Herson in France. No after-settlement occurred.

This method of treating quicksands with coarser sands and gravel appears to have been of much service in many cases. Trautwine records an example of its successful use in making a foundation over quicksand for the brick aqueduct for supplying Boston with water.

Supporting Power of Soft Soils.—In speaking of soft soils we generally mean those which are referred to as being compressible, though really this is more or less of a misnomer, for they are regarded as being the more compressible in proportion to the amount of water they hold, and yet we know water is practically incompressible. Debauve, in his excellent work on foundations, makes this distinction clear, and classes such soils as "*mobile*," movable, which in itself is a true definition of their characteristics.

The alluvial mud of many rivers gives us the best example of soils of this kind, and in this country, as in general in most others, the soft soils are usually found at the lower end of rivers flowing through valleys of considerable width, and emptying into the sea or large lakes, where the force of their currents is checked by the larger body of water, causing the detritus held in suspension to be deposited in beds of greater or less thickness; or by overflowing their banks and spreading far and wide throughout the valley the waters lose sufficient velocity to carry the suspended matter further.

An example of the greatest magnitude, of such formation, is seen in the country adjacent to the lower Mississippi, and much of the State of Louisiana has been formed in this way. Here is to be found the "*prairie tremblante*," or trembling prairie—vast stretches of land composed of a semi-fluid, mud subsoil, overlaid by a mass of decayed vegetable matter, and which, tied together by rootlets, forms a more solid, but trembling, crust.

It is impossible, of course, to solidly found anything upon such soil; but rather must any such attempt be regarded as a problem of flotation in a muddy liquid. Yet we are often called upon to construct railroads, bridges and buildings in soil but a trifle more solid and homogeneous.

The supporting power of all soils is of course dependent more or less upon the depth at which the foundation is made, and in the alluvial soils such as we are now considering this is of more importance than in other kinds. We have not time at our disposal in this paper to enter into this matter more fully, and in our remarks we have treated upon the supporting power of soils as we generally use them, and not much affected by depth.

The softer clays really belong to and should be treated in the same manner as the soft alluvial soils to which we are now alluding.

The actual supporting power of such soils can hardly be given in figures which can be of much real value. In the city of New Orleans, for instance, almost without exception, we find recorded the serious settlement of all the larger buildings and structures, which have been founded directly upon the alluvial soil, and in many cases the load per square foot is much less than a ton. From some experiments made in India in alluvial soil, the safe load per square foot is given as 1 ton; while Sir Charles Fox* finds it to be only 1,680 pounds for the soil which he tested.

Experiments to determine the weight which can be safely placed upon soft soils have often been made, but are not generally of much value, unless the area of soil tested is of about the same extent as the base of the foundation to be placed upon it. This was very clearly shown in France some years since by a series of experiments made in the soft alluvial soil of the valleys of Vilane and l'Oust.†

A number of small piers of masonry, 6·56 feet square, were built at different points, and made of such a height as to give a load per square centimeter double that of the large embankment which it was the intention to afterward construct. It was supposed that these piers would settle deep into the mud, but they really settled a comparatively small amount, while the embankment, covering a great, broad area of base, but exerting a pressure per square centimeter of only one-half that of the piers, showed in all cases very much greater settlements.

The explanation was simple: if a small pier, with a square base, is pressed down into the soft soil, the frictional resistance against the sides of the compressed ground is proportional to the length of these sides; while a square pier of, say, double the width would experience a frictional resistance just twice that of the first pier. In other words, this resistance is directly proportionate to the *length* of the perimeters of the bases. But the *area* of the base of the second pier is four times that of the first, hence we see that, with an equal pressure per square unit of base, a small pier would have much more resistance to overcome than a large one, and that one would be at fault to take as a correct measurement of the supporting power of the soil the results obtained from loading but a limited area. Experiments upon the soil in New Orleans, made in 1851 and 1852, and which are recorded in *Van Nostrand's Magazine*, Vol. 27, showed analogous results.

Stated then as a proposition: *The supporting power of soft soils is greater in proportion as the loaded area is limited*, or, conversely, *large areas of soft soil will not support as much weight, per unit of surface, as more limited areas of the same soil.*

This principle is most important, and should not be neglected by engineers designing foundations. It is applicable to the supporting power of bearing piles, and hence any formula for the same which does not make a distinction due to different sectional areas of the piles is incorrect in theory.—*Journal of the Association of Engineering Societies.*

MANUFACTURE OF GLASS BOTTLES IN GERMANY.

By D. J. PARTELLO, U. S. Consul, Dusseldorf.

WITHIN the consular district and about five miles from the city of Dusseldorf, in the valley of the Rhine, at the base of a low range of hills, is located the glass bottle manufactory of Ferd. Heye, of Gerresheim, claimed to be the largest establishment of the kind in the world owned and operated by one individual. Its convenience for obtaining supplies is second to none; two lines of railroad, both owned by the German government, pass the establishment, one line lending direct into the yard.

The small German town of Gerresheim, containing about 3,000 inhabitants, immediately adjoins the works, the two being inseparable on account of the mutual interests involved, and it is properly said here that

* Trans. Am. Soc. C. E., Vol. 8.
† Trans. Am. Soc. C. E., Vol. 14.

* Clemann's Railroad Engineer's Practice.
† Annales des Ponts et Chaussees, 1864.

Gerresheim is the glass works, and the glass works Gerresheim.

Upon the side hills adjoining the town, within a few hundred yards of the establishment, may be found millions of loads of rich, soft, golden yellow sand of the best quality, while half a mile further away, at another range of hills, are quantities of the best white sand. Supplies may be had at the cost of hauling; both sources are availed of, and are considered of the greatest value to the works.

The town of Gerresheim is located on the line of railroad leading from the Rhine to Berlin *via* Barmen and Elberfeld. The section passing the glass factory is said to be the second line of road built in Germany, the first having been constructed from Nuremberg to Kehl, upon which was operated, in 1837, the first engine introduced into this country.

In this connection it is strange to observe that while throughout Germany the greatest improvement has been made in the past twenty years in the matter of good rolling stock, depots, and lighting and heating facilities, yet on the stretch of road between Gerresheim and Elberfeld the crossing of the hills is still accomplished, as it originally was fifty years ago, by means of stationary engines and cables.

BUILDINGS AND GROUNDS.

The buildings and grounds of the works in actual use cover an area of about 60 acres. The grounds are laid off in divisions, squares, and streets, and are properly graded and paved where necessary. Parks are arranged for the storage of bottles, and tracks constructed for the transportation of material and for other purposes. The buildings are modern in appearance, many in number, and are constructed in a substantial manner of brick, stone, and cement. The smoke stacks, or large brick cupolas, are ten in number, with an average height of 100 feet, and have the appearance of a village of spires. The grounds are entirely surrounded by a heavy brick wall, and watchmen are stationed at the gate and other exposed points, and no one is allowed to go through the place without permission or unaccompanied by a guide.

Adjoining the works, and within the inclosure of a large park laid out into squares and streets, are built about 400 dwelling houses, two stories in height, uniform in color and appearance, provided as homes for those of the employes who desire to occupy them at a low rent. Two, and sometimes three, families occupy a house. A small garden adjoins each, shade trees are scattered over the place, and the whole, being neatly paved, drained, and kept in perfect order, presents the appearance of a small village. Those who occupy the houses are furnished fuel and light at cost prices, and everything is done to make them contented. Watchmen are stationed through the streets, regular rules in regard to cleanliness and other matters are enforced, and the best order at all times prevails. At the extreme lower end of the park, near the main gate, surrounded by about two acres of ground neatly laid out with walks, flower beds, etc., stands the plain and unpretentious cottage home of the owner, Mr. Heye. It is two stories high, the outside being similar to the other buildings, and the interior is well but plainly furnished, without any attempt at display—about the same as a neat American cottage home.

AT THE WORKS.

I made a visit by appointment to the works a few days ago. I was met at the station by Mr. Heye, and was conducted to the office building near the main gate, where I observed in the different rooms about twenty clerks employed, from general appearance, with the greatest system in the arrangement of their several duties. I was accompanied by one of the chief officials through the establishment. I may add here that the main office building is connected by telephone with the cities of Dusseldorf and Cologne, and by special telegraph wire to the main office in Dusseldorf, thus virtually having communication by means of the cable with the entire business world.

CAPACITY OF THE WORKS.

The capacity of the works is about 300,000 bottles per day, but at the present time, and usually, the number of bottles made daily averages about 200,000. A good share of the work under present contracts is for the American market. For a year or two past the orders from America were small, but since the 1st of January the shipments have increased until they amount at the present time to 300,000 to 500,000 bottles weekly, which are invoiced at the Dusseldorf consulate consigned to dealers in New York, St. Louis, Milwaukee, Chicago, and Cincinnati, in bills of about 1,000 gross each.

Formerly the wine merchants imported their Rhine and Moselle wines in bottles, but some advantage to be gained in the transaction has prompted them to buy their wine in bulk, ship the bottles separately, and do the bottling in America.

KIND OF BOTTLES MADE.

The different varieties of bottles made at this establishment number now about 5000, which may be said to include nearly every kind and shape of bottle in existence. Here I found all the different kinds of mineral water bottles so common in use in America, from the egg-shaped soda through the list, and also in white glassware, with fancy glass stoppers, all the varieties that are in use in the drug stores. Further there were Irish whisky, English porter, the good old American whisky, five to the gallon, large Spanish wine and soda bottles, French champagne of all kinds, Rhine and Moselle wine, and in short orders filled monthly from North and South America, England, Ireland, Spain, Portugal, Germany, and even remote places, for all kinds, varieties, and colors in existence. Shipments, according to the custom of the trade, being made with breakage at the risk and cost of the purchaser. It was shown by the books that a London firm had ordered annually for years past 10,000,000 to 15,000,000 of a certain kind of mineral water bottle for mineral water procured from German springs and shipped from London to all parts of the world.

SAMPLE ROOMS.

I next visited, in one of the large buildings, the sample rooms, consisting of two, each about 20 feet square, the walls fitted up with shelves containing about 10,000 to 15,000 bottles, all arranged according to size, number, and quality, and properly labeled, with the number of the mould also noted. The samples included duplicates of all bottles made at the works, besides a complete set of samples of foreign manufacture, such as those from the glass works of France, England, and the United States. My guide handed me from the shelves bottles made at the glass works of Baltimore, Md., and with them the same character of bottle made at Gerresheim. The main points in difference would be readily observed, the principal one being the seam always found running up the side of the American bottle and marring its appearance, which by the manner of blowing was obviated here, and the claim made that the American bottle was inferior in that and other respects. The sample room was interesting with its thousands of bottles labeled and arranged in perfect order as to size and color, the room being under the charge of one person, who is held responsible for its care and appearance.

MOULD ROOM.

In another side of the same building was located the mould room. This room, always kept locked, is about 20 feet wide by 60 feet long, arranged with shelves upon which are placed in regular order the moulds of different kinds and sizes. Besides, on the floor in rows up and down the middle, I observed moulds of all kinds placed according to size and number. The uniformity of the labels and arrangement of the great number of moulds in the room giving the whole the appearance of order and regularity, and rendering it an easy matter to select from out the number any design wanted without trouble or delay.

LIGHTING OF THE WORKS.

The entire place is lighted by electricity. The electric light, so common in America, is fast finding its way through this entire country, and on one's travels it may be seen at all the railway stations and also at most of the large manufacturing establishments of any note. It is claimed that at this time there are about 250,000 electric lights in use in Germany alone. Chiefly American patents and American agencies have been established all over Europe, the headquarters of the Edison system, doing a thriving business, located at Antwerp under the charge of Mr. Dyer, of Washington, D. C.

The owner of this glass factory, with an eye to future business, purchased a most complete outfit for lighting the entire place from a dealer in Cologne, at a cost of about 10,000 marks, the plant having a capacity for not only the works, but the village of Gerresheim adjoining. The main railroad station of the town is located at the gate of the works. The lights are furnished the government for the station use at a compensation sufficient to pay a fair interest on the whole investment, and at a later period, when it is expected the town will avail itself of the convenience, it will be a good paying investment, in addition to the lighting of the establishment, which will then be obtained free of cost.

SUPPLY OF COAL.

The glass factory at Gerresheim is very fortunate in its location as to the supplies for its purposes. The greatest quantity of sand is within a few hundred yards. A small adjoining town furnishes its labor, and the coal mines of Westphalia, in the neighborhood, supply the required coal at a low price, which is an important item. Within the valley of the Ruhr, beginning at a point two or three miles from Gerresheim, and running a hundred miles on farther north and east, are to be found the extensive and never failing coal mines of western Germany, called the "Westphalia mines." The production last year amounted to about 27,000,000 tons, the largest consumers being the manufacturing establishments of all kinds so thickly scattered over the western section of Germany. The coal used by the glass works is brought down the valley of the Ruhr and Gerresheim, switched off on a side track, and carried direct into the yard of the works at a small advance over prices at the mines. When surprise is manifested at bottles being manufactured so cheap that they can be transported to the United States, freight, duty, and breakage allowed, sold at a profit in the competition with home industries, it may be explained by the excellent location near a base of supplies, exceeding low price of labor, and good management on the part of the conductors of the enterprise, avoiding strikes or any interruption in the steady and regular course of business.

NUMBER AND WAGES OF EMPLOYES.

The number of persons employed in the entire works varies from 1,800 to 3,000, in which are never less than the former number, including many female employes, the entire number varying according to the contracts to be filled and work on hand. It is a very common thing to see women employed in this country, even in the most menial street service; but at the glass works their occupation seemed to be confined principally to the packing department and cleaning and clearing up the yard.

In three or four of the large buildings the furnaces are kept steadily going, and the blowing of bottles continued night and day. The men who perform this class of work, considered the most important in the establishment, number alone about 400, and are paid by the piece, or according to the number of bottles made. Each workman has one apprentice allotted to him to learn the trade and as his assistant, and the bottles are all specially marked to show by which set of workmen made.

The men are assured steady employment, prompt pay, and they appear to be perfectly contented and healthy. They all live in either Heye village or at the town of Gerresheim adjoining. If their houses belong to Mr. Heye they are charged a small rent, about 4 per cent. on the cost of the building, not including the ground, which is charged against their weekly pay. The clothing of the employe is coarse, but clean and comfortable, and the food simple, consisting of beer, bread, coffee, tea, cheese, vegetables, with meat about once a week. Their contentment is due to the agreeable social conditions among themselves—the absence of real suffering, steady employment, and ignorance of the world that lies beyond the limits of their quiet village.

The pay is small, but the cost of living with them is also comparatively light. The highest daily pay of the blowers averages from 3½ to 5 marks (87 cents to $1.20). The furnaces that are kept going at night are run by three sets of hands, who divide up the time and keep the work steady for the twenty-four hours of the day. The excellent lighting of the establishment by electricity admits of the work being carried forward without interruption, and ordinary employes are required to perform about eleven and one-half hours' labor each day, going to work at six o'clock A. M. and working until 7.30 P. M., with an allowance of one hour for dinner, and both morning and afternoon half an hour for beer, coffee, etc.

The wages of apprentices are about 50 pfennigs (12½ cents) per day for the first year, with a slight increase each year; the women generally not over 2 marks (48 cents); other employes from 1½ to 3 marks per day, according to the special class of work engaged upon; 2½ marks being about the average pay of general employes.

STORAGE PACKING.

On the outskirts of the yard, against the heavy brick walls, open sheds are constructed where the packing is chiefly done, and in the open squares of the yard, between the streets, parks for storage are well laid out and graded. Some 5,000,000 or more bottles are generally on storage in the yard, piled in perfect order, the whole presenting somewhat the appearance of an ordnance yard with its storage of shot and shell. Sizes and qualities are arranged together, and necessary wooden signs stationed at the head of each pile.

The government railroad runs through the yard, and shipments for Germany are packed loosely in the cars with straw, bottles for export being in sacks; no charge is made against the employes for breakage. The yard has the necessary supply of trucks, cars, and well laid tracks for all conveniences. The packing for export is done under the large side sheds, mostly by women; coarse canvas is used for sacks, containing 1 gross, and it is remarkable to see with what dexterity in this packing process each bottle is wrapped in a small bunch of straw—layers made of 1 dozen, with straw between—the whole sewed up, making an oval compact bundle that can be handled roughly without much danger of breakage, and all without the aid of machinery of any kind.

BOTTLE BLOWING.

As is the usual custom in all bottle making, the heated material is taken from the furnace on the end of an iron pipe or tube, placed in the mould by the apprentice, and then the process of blowing into shape follows. One of the most noteworthy points, however, is that the rod or pipe is repeatedly turned by the workman during the process of blowing or formation of the bottle, which gives it a perfectly smooth and complete appearance when done, and avoids the ugly seams or ridges often seen up the sides of bottles of American manufacture.

I inquired particularly on this point, and was informed that the workmen in American and English shops refuse, for some reason, to perform this special extra labor of turning the bottle in the mould, which the employes here, according to the custom of the trade, are obliged to do, and, therefore, for that special reason the bottles are claimed to be superior to American manufacture, and as far as I was able to judge, they were in general appearance. When completed they are carried by boys, three at a time, on a forked iron rod to the cooling ovens, and not exposed to the air for three days, that being the time allowed for cooling.

The furnace heat, which does the melting of the material, is produced by gas and not by coal. Adjoining the furnaces are large arched pits sunk below the surface of the ground, in which gas is made by soft Westphalia coal, which is brought direct from the mines into the yard.

The gas when made is stored in cylinders near and conveyed by 4 to 6 in. pipes direct to the furnaces and discharged over the top of the mass of melted material into the blaze.

An attendant at the side furnace has the care of supplying gas to the fires, which is done by two different pipes, let in with cold air, to form a more perfect draught. The current of gas, changed from one tube to the other by means of a crank every half hour regularly, the supply and quantity of heat being simple and perfect. In my examination of this part of the establishment I found most complete gas works under ground. Only perfect bottles are allowed to go out on orders, the piles being carefully assorted, and defective ones used over again as so much material.

MATERIAL OF WHICH BOTTLES ARE COMPOSED.

In the large building with concrete floor connected with the furnaces by means of tracks and cars below, covered passages overhead, is located the mixing place for the material, and it is here prepared for the furnaces.

The sand is handled by means of the yard car trucks, and before use is burned and sifted. The material when prepared is carried from the room by means of the overhead passage in wooden box tubes direct to the blowing furnaces and supplied to the furnaces through small round holes about 12 in. in diameter.

There is no doubt that some secret exists in the composition of this mixture, but general observation only revealed the use of burned and sifted sand, lime, and sulphur in certain proportions.

In conclusion it may be noted that Mr. Heye, the present owner of the large establishment, a man about fifty years of age, made his beginning in life unaided, and by his industry and preseverance brought to great proportions this well known factory that bears his name. He laid the foundation a few years ago on the present site, with a dozen employes and two small buildings, and his remarkable success is a parallel to the success of Krupp, who in like manner founded the celebrated Krupp gun works, at Essen on the Ruhr. Mr. Heye has recently received from the German government the title of "Commercien Rath" (adviser), as a recognition of his rare business qualifications.

Since the beginning of this report a contract has been entered into between Mr. Heye and the Apollinaris Mineral Water Company for the delivery within one year of 19,000,000 bottles at the following prices, viz., 58 marks per 1,000 large quarts; 75 marks per 1,000 small pints, 2 per cent. discount.

Dusseldorf, March 20, 1888.

VACUUM STOVE FOR DRYING MALT.

THE accompanying engraving represents a drying stove which is particularly distinguished from all those hitherto employed by the fact that the drying is here obtained in a vacuum. We have here, as may be seen, a new application of the principle long employed with great economical advantages in refineries and sugar works for the evaporation of juices, etc.

Mr. Passburg's stove is especially arranged for the drying of malt and distiller's wash, where it gives the same advantages as those afforded by apparatus for boiling in a vacuum employed not only in refineries and sugar works, but also in manufactories of dyes from woods, pharmaceutical products, etc.

By this system, in fact, the evaporation goes on with extreme rapidity, in consequence of the difference that exists between the temperature of the heating surface and the boiling point of water. Since, in the operation, the temperature of the malt does not exceed 50° C., the nutritive portions do not undergo any sort of alteration or deterioration.

The malt or wash is put into the stove in its natural state of hydration, just as it was produced, and without having undergone any pressure. The residua are constantly converted into a concentrated alimentary substance of great value, with all the nutritive richness preserved. The yield in dry residue is therefore obtained without loss, at the rate of about 36½ pounds of dry malt per 100 pounds of malt employed in brewing.

The heating of the stove is done with steam coming directly from the generator, or by the waste steam from the motor, or by return steam already utilized. It follows that a brewery can, in this latter case especially, dry its malt almost without expense.

As the rotary speed to be communicated to the apparatus is very slow, say five revolutions per minute, the motive power necessary for a stove of medium size (16 feet in length by 5 in diameter) is but about 3 horses. It takes but one man to run it.

Under such circumstances, a stove is capable of evaporating 375 gallons of water per hour, which is equivalent to the drying of 2,200 pounds of malt in the same time.

Fig. 1 represents a stove of large size in vertical section passing through the longitudinal axis.

Fig. 2 is a transverse section through the hopper, according to the line, 1–2. As a whole, this apparatus consists of a horizontal cylinder, A, with double sides, which is the stove properly so called, and which is surmounted by a second cylinder, B, performing the role of a heater and connected with the hopper, C. A tubular connection provided with a register, D, permits the material to pass from the heater into the stove, and from the latter, through a similar tubular communication, E, to fall entirely dried into the cylindrical receptacle, F.

The direct entrance of the steam takes place in the interior of the stove through the tubulure, *a*. It distributes itself in the central cylinder, A′, and in the tubes, A^2, which surround the latter, and the entire length of which it passes through and escapes through the tubulure, *a*′, to enter the internal cylinder, B′, of the heater, B, through the tubulure, *b*. From this it finally escapes, in great part condensed, through the tubulure, *b*′.

An air pump combined with a condenser is connected both with the interior of the cylinder, A, through the box, G, and with the interior of the drying cylinder, B, through the box, H.

Motion is communicated by a vertical shaft provided with two pinions that gear with the two wheels, R and R′, which are keyed respectively upon the hollow journals *a*′ and *b*′, which are cast in a piece with the ends of the internal cylinders, A′ and B′.

The outer cylinder, A, of the stove is supported at its two extremities by two cast iron legs, J, which rest upon double T irons, and the cylinder, B, of the heater by columns, K, and by two rows of double T irons at right angles with each other, the transverse irons supporting the cast iron legs, J′, of the heater.

If, from these general arrangements of the apparatus, we pass to an examination of the principal details of construction, we see that the mounting of the journals *a* and *a*′ and *b* and *b*′ of the inner cylinders A′ and B′ is executed with the greatest care in order to avoid leakages of steam. It will be remarked, in fact, that bronze rings are fixed in the journals, cast in a piece with the ends of the cylinders, and that stuffing boxes, also provided with bronze rings, secure tightness and freedom from friction through lubricators applied to the fixed journals.

The cylinder, A′, is connected at its extremities with disks cast in a piece with the journals, *a* and *a*′, so as to form two chambers, K′, that permit the steam, divided at the entrance by the cap, *k*, to enter the tubes, A^2, and, at the exit, to be collected by the plunge tube, *k*′, along with the condensed water, which, with the steam, can escape through the hollow journal, *a*′.

Rings provided with arms designed to carry the paddles, L, are fixed upon the cylinder, A′, as are also two disks, *l*, which support the heating tubes, A^2, and which, without that, might bend, since they are held at their extremities only by the sides of the chambers, K′.

The inner cylinder, B′, of the heater, B, consists of two equal sections connected by a bridge and bolts, and cast with hollow projections, b^2, spirally arranged so that they may lead the material thrown in through the hopper to the opposite extremity. During its travel, the material is given a rotary motion by paddles, *m*, of U iron, which are held by clamps that are cast in a piece with the cylinder and are distributed throughout its length.

It will be remarked that the two boxes, G and H, that receive the pipes which establish their communication with the pneumatic machine are provided with clack valves for regulating the section of the passage, and that they are furnished with roses, *g* and *h*.

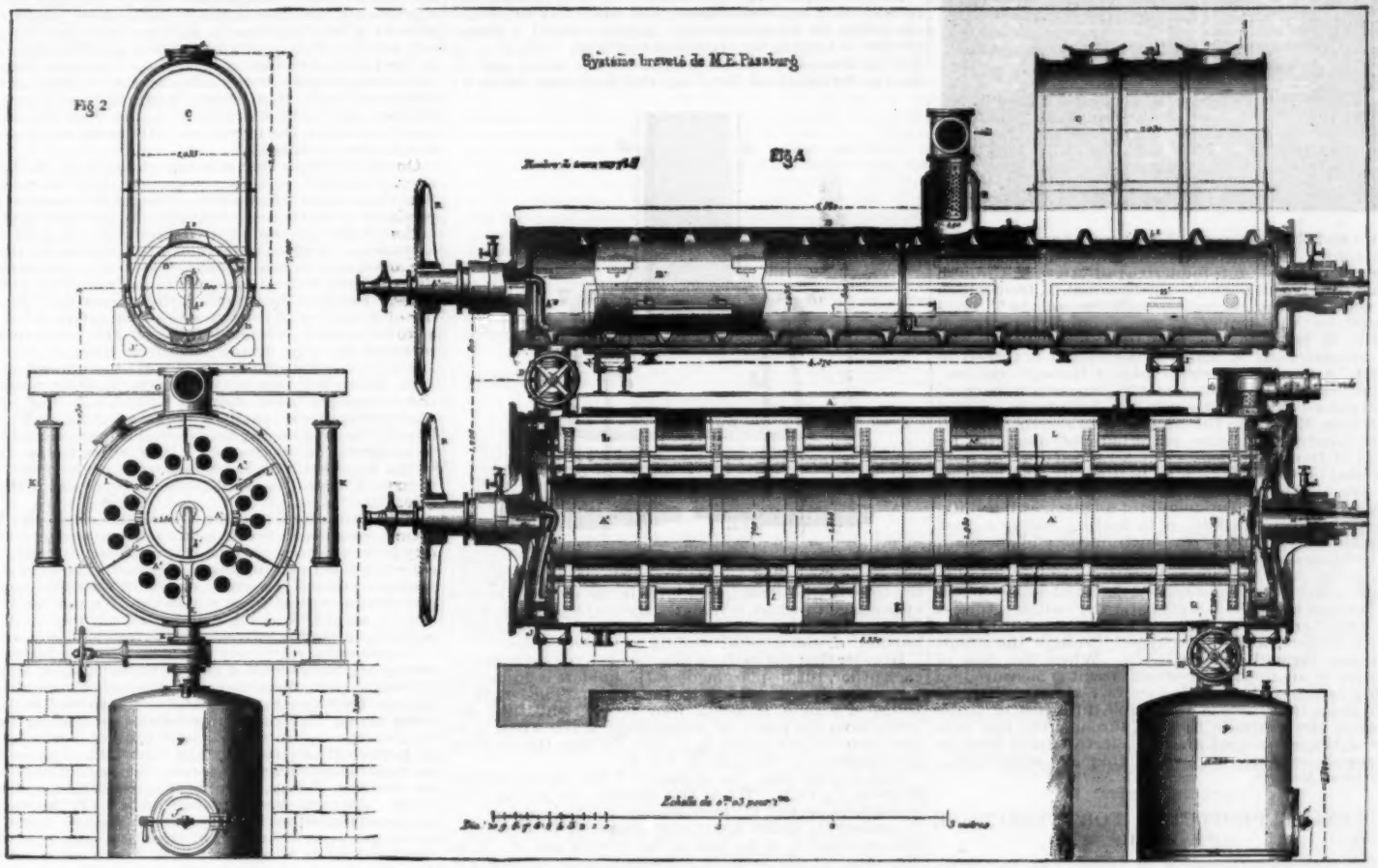
The whole thus arranged, the operation is as follows: An elevator raises the malt or other material to the hopper, C. When the latter is full, the covers, *c*, are put on, steam is introduced, and a vacuum is formed in the apparatus. Then, through the motion communicated, the material in the heater, B, is carried along by the spiral bosses, b^2, of the inner cylinder, B′, and is stirred up by the paddles, *m*, until it reaches the extremity. Here it meets the tubulure, D, whence it falls continuously (the register being open) into the stove, A, properly so called. The contact that it undergoes with the heated tubes, A^2, and the heated inner cylinder, A′, along with the lifting it gets while being carried along slowly by the paddles, L, completely dries it by the time it reaches the extremity. Here there is a tubulure, E, whose open register allows the dried material to fall into the receptacle, F. When this latter is full, the register is closed, and the contents are removed through the man-hole, *f*, without any cessation in the forming of a vacuum. When all is removed, the man-hole is closed, the register, E, is opened, and the malt again begins to fall into the receptacle. This simple and easy operation needs to be renewed every two or three hours only.

The malt is introduced into the hopper without any reduction of the vacuum, so that the work goes on regularly and continuously.

This stove, which as here described is arranged especially for drying malt and distiller's wash, may, through certain modifications, be put to numerous applications, principally for drying chemical products, such as extracts, dyes, salts, etc. For such purposes, the apparatus is modified as follows: The stove properly so called consists of but a simple horizontal cylinder of iron plate or cast iron surrounded with a steam jacket and provided at the extremities with self-closing doors. A tubulure communicates with the vacuum pump and the jacket is provided with admission and eduction valves. Internally, the stove is provided with rails connected at the two extremities with the tracks that serve for the maneuver of double floored cars, designed to bring and carry away the material. To this effect the railway establishes a communication between the stove and a loading room, and between the latter and a heating chamber. The floors of the cars are covered with refractory bricks or boxes of sand, which, in the furnace, take the necessary quantity of caloric for evaporating the liquid portions in a vacuum, say 100° to 300° C. The refractory bricks thus form accumulators of heat, and must consequently be so much the thicker in proportion as the material is the more difficult to dry. In all cases, the thickness is so determined that the heat to be communicated to the product shall not exceed 50° C.

The material to be dried is spread over plates or capsules that are laid upon the refractory bricks of the cars. Thus loaded, the cars, to the number of three, are run into the drying cylinder, which is then closed and a vacuum at once formed in it.

The desiccation begins, the heat of the bricks makes itself felt, and at the end of a few hours the drying draws to a close, the bricks having given up their caloric without the material having suffered from too high a temperature.



VACUUM STOVE FOR DRYING MALT.

When the operation is finished, the clack of the vacuum pump is closed, and air is allowed to enter the drying cylinder, then, after opening the door opposite that of the entrance, the cars are drawn out and the capsules over the heat accumulators are removed, while those on the lower floor are left. After this the dried material is removed, and, if it is to be reduced to powder, it is carried to a mill located in the loading room, which contains likewise a press designed to spread the pasty materials on the plates in regular layers of from ¾ to 2½ inches.

As for the cars containing the chilled refractory bricks, they are returned to the furnace to get a new supply of heat. The work may therefore be considered as continuous, since, while the cars that have been used are reheating in the furnace, others loaded with moist material are undergoing a drying in a vacuum.

The time that it takes to do the drying depends upon the material. When the latter can support a high temperature, the operation can be hastened. If the contrary is the case, it will be retarded. It results that the performance of the apparatus is dependent upon the ease or difficulty with which the material may be dried.—*Publication Industrielle.*

NEW COMPOSITE ELECTRIC BALANCE.*

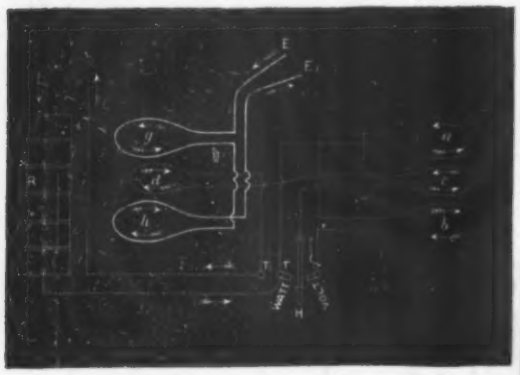
By Sir WILLIAM THOMSON, F.R.S.

THIS instrument has been designed for the purpose of providing, in one instrument, the means of measuring (*a*) the difference of potential between two points of an electric circuit, as, for instance, the difference of potential between the supply conductors of an electric light installation, (*b*) the current flowing in such a circuit, and (*c*) the rate of working in the circuit. The

* Abstract of a paper read before the Philosophical Society of Glasgow.

instrument thus forms a combined voltmeter, amperemeter, and wattmeter. The general form of the instrument is similar to that of the standard centi-ampere or deci-ampere current balances, and it consists of (1) two coils of silk-covered copper wire fixed one above the other with their planes horizontal on a slab of slate, (2) two coils of similar wire made up in the form of anchor rings and fixed to the ends of a balance beam, (3) two coils fixed similarly to (1), but capable of carrying currents up to 500 amperes. The beam of the balance is suspended by two flat ligaments of fine copper wire in such a position that one of the coils fixed to the ends of the beam is suspended midway between the fixed pair of fine wire coils (1), while the other suspended coil is similarly placed relatively to the thick wire, or current coils. When the instrument is used for the measurement of alternating currents, the current coils are made by two or three turns of a stranded conductor. Each wire of the stranded conductor is covered with silk, so as to insulate it from the others, and in order as far as possible to annul the effect of induction in causing the current to be different at different distances from the axis of the conductor, the strand is given one turn of twist for each turn round the coil.

The arrangement of the connections in the instrument will be readily understood from the figure, which shows diagrammatically the arrangement of the coils. In this figure *a* and *b* represent the fixed fine wire

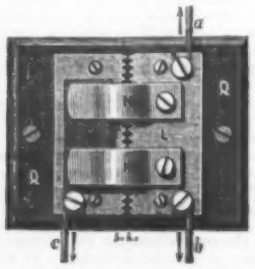


coils, *c* and *d* the suspended coils, and *g* and *h* the current coils. The instrument is joined in the circuit through a suitable anti-inductive resistance, R, through which the current passes to the terminal, T, from which the course of the current through the coils to T_1 is indicated by the arrows in the diagram, the switch handle, H, being in this case turned to "volt." For the measurement of amperes the switch is turned to "watt," a measured current passed through the suspended coils of the balance, and the currents to be measured passed through the coils, *g h*, by introducing the electrodes, E E_1, into the circuit. The current through the suspended coils may sometimes be measured by means of the instrument itself arranged for the measurement of volts. This may be done by first measuring the current which the difference of potential between the supply conductors of an electrical installation, or between the poles of a battery, causes to flow through the fine coils of the instrument and its external resistance, and then turning the switch to "watt," and, at the same time, introducing a resistance into the circuit equal to the resistance of the fixed coils. When the balance is used as a wattmeter the switch is turned to "watt," and the terminals, T T_1, joined to the supply conductors, while the current through the circuit is passed through the coils, *g h*. When the rate of working in an alternate current circuit is measured by such a balance, the anti-inductive resistance, R, must be so great that there is no sensible difference of phase between the currents flowing through the fine wire coils of the instrument and the electromotive force on the supply conductors to which they are connected.—*Electrical Review.*

LIGHTNING PROTECTOR FOR TELEPHONE APPARATUS.

THE Telephone Company of Austria has just introduced into its lines a lightning protector in which there has been quite happily combined the two types of protectors with points and with ribbons or plates. Two models are made, one for telephone lines with simple wires and the other for complete metallic lines.

The figure shows (of actual size) the first model of this lightning protector. Two brass plates, T and L, are



screwed side by side to a block of wood, Q. The edges of these plates are cut into the form of teeth, which closely adjoin each other, but which do not touch. A wire, *a*, runs from the plate, L, to the telephone line, and another, *b*, runs to the apparatus. The ground plate, T, is connected with the ground wire by *c*.

The distance between the two plates is scarcely equal to the thickness of a card. Over the toothed edges pass two springs, N, which are screwed to the plate, L, and the free ends of which exert a certain pressure upon the plate, T, without, however, directly touching it, on account of a piece of silk or waxed linen, S, that is interposed between the plate, T, and the ends of the two springs.

The telephone currents cannot pass through the silk to reach the earth, while feeble atmospheric currents will traverse it.

It is unnecessary to say that the silk should be renewed after being burned by a discharge of this kind. Strong atmospheric discharges pass from the teeth of the plate, L, to those of the plate, T, and reach the earth through the wire, *c*.

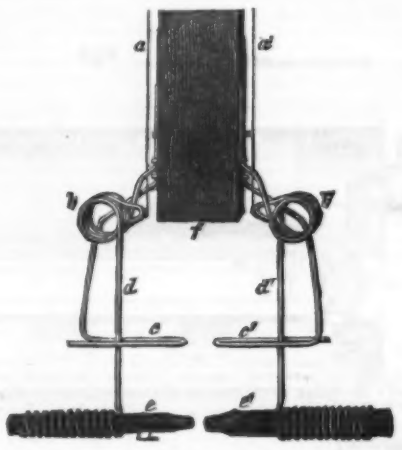
In the lightning protectors designed for double lines, the plate, T, is placed between two line plates, L, and the edges of these three plates are toothed. Each line plate then carries a spring whose free extremities rest upon the same piece of silk on the plate. This latter is no larger than in the former model.—*La Lumiere Electrique.*

A NEW ELECTRIC REGULATOR.

MR. C. POLLAK, an electrician who is not unknown to our readers, has just devised an ingenious electric regulator which is so simple that any amateur can construct it, and that, too, at little expense, as will presently be seen. A few small pieces of wood, some brass, and four wires are all that is necessary for the construction of a regulator which, we hasten to say, in order to meet the objections of skeptics, will operate perfectly well, as we have assured ourselves at the laboratory of the Sorbonne, where several models constructed by the inventor have operated in a very satisfactory manner.

In addition to its great simplicity, this lamp has the further advantage of being based upon an entirely new principle—that of the expansion of the wires that lead the current to the carbons under the influence of the said current and its variations, the same part serving at the same time for the lighting, or formation of the arc, and for regulation, in measure as the carbons wear away.

The accompanying figure shows the first of these apparatus that was constructed, and will easily allow the operation to be understood. Along a board, *f*, about six feet in length, are stretched two brass wires, *a a'*, $\frac{1}{10}$ inch in diameter. These are fixed at the upper part to the two terminals of the lamp and kept taut below by



the action of two double spiral springs, *b b'*. These latter are formed of simple brass wire, and are fixed at the sides of the board, and form in the center a lateral appendage to which is soldered the corresponding wire. At the other extremity they are prolonged by a straight portion, *d*, and a spiral forming a carbon holder.

In order that the carbons may be always kept opposite each other, the displacement of the holders is guided by a bent wire, *c c'*, affixed to the board. The length of the lever arm, *d*, is about four inches, while the distance from the point of attachment of the wires, *a*, to the center of the spring is $\frac{1}{10}$ inch, so that the motions are amplified in the ratio of 1 to 5.

In a normal state, the distance of the carbon holders is about $1\frac{1}{4}$ inch. When the carbons are put in, each is made to project $1\frac{3}{4}$ inch, so that the holders have to be spaced $2\frac{1}{2}$ inches apart, corresponding to an elongation of about $\frac{1}{4}$ of an inch of the wires *a* and *a'*. If, at this moment, the lamp be interposed in an electric circuit, the current will pass into these wires and heat them, and the springs being thereby bent back, the carbons will tend to separate, and an arc will form. The length of the latter will be determined by the condition that the tensions of the springs and wires balance each other for the corresponding strength of the current, the difference of potential being supposed constant, for, as the regulation is made in series and bears on the current, we ought naturally to group these lamps in derivation.

In measure as the carbons wear away, the resistance of the arc increases, the current diminishes, and the wires contract, allowing the springs to carry back the carbons. It is easy to see, and experiment shows it, that the current tends to diminish slowly in measure as the lamp burns. Such gradual diminution in luminous intensity offers scarcely any inconvenience in a lamp of this kind. With the divisions that we have indicated, the lamp will operate for about three hours.

We just gave the diameter of $\frac{1}{10}$ inch for the regulating wires, and this is determined by the value of the current adopted, five amperes, and the condition that the temperature of the wire be relatively high (about 120°). If the temperature is too low, the regulation will be effected too slowly, and if it is too high the elasticity of the wire will be destroyed, and the latter will elongate permanently under the action of its spring.

The temperature of 120° has been calculated by means of the well known formula:

$$d = \sqrt[3]{\frac{4\,R\,i^2}{\pi^2\,t\,h\,J}}$$

where *t* is the elevation of temperature, R the specific resistance, *i* the current, *h* the coefficient of regulation (0·0002), *d* the diameter of the wire, and J the mechanical equivalent of heat.

As may be seen, the length does not here figure explicitly, but it in fact determines the current. In order to keep the latter constant by diminishing the length, it is necessary to increase by so much the proportion of amplification of the levers, and this has been done in a later model of smaller dimensions. If, with the same temperature, we desire to modify this current, it will suffice to shunt the regulating wires by properly calculated auxiliary resistances.

If the reader has grasped the operation of this lamp, he will at once see that the ambient temperature plays an important role, since it modifies the initial tension of the wires. To get free from this influence, which in certain cases would necessitate a different regulation for each temperature, it suffices to replace the wood by a frame of the same metal as the wires, *a*. We shall simply state, by the way, that Mr. Pollak has likewise adapted his system to lamps regulatable in derivation, with vertical carbons, by making the regulating wire act upon a ring brake that allows the upper carbon to slide.—*La Lumiere Electrique.*

MOTORS FOR NAVAL AND MILITARY USE.*

By Lieut. B. A. FISKE.

THE reply of Clerk Maxwell, when near his death, to the question, "What has been the greatest discovery of the age?" "That the Gramme machine is reversible," shows, in the light of recent years, an inspiration almost prophetic. Granting all the benefit to mankind resulting from the numerous other discoveries with which the century has been laden, surely none surpasses in far-reaching consequences the very simple one that, if a current of electricity be sent through a dynamo from an external source, the dynamo will at once become a motor, *i. e.*, an engine, and the most efficient engine known.

But so rapid has been the development of the electric motor that many persons, whose attention has been devoted to other things, have failed to grasp its full significance, and the object of the present paper is to present a brief statement, showing, not that the electric motor is a piece of apparatus of possible usefulness in the future, but that it is to-day a complete, durable, and strong engine, better adapted for handling guns in ships and forts than steam, hydraulic, or pneumatic engines, and more desirable for use in ships for certain auxiliaries than the numerous little steam engines with which they are filled.

On the principle that it is best to begin at the beginning, Faraday's pregnant discovery may be recalled, that the movement of a coil of wire near a magnet pole produces a current of electricity in the wire, and the action of the dynamo at once stands out clear, because a dynamo is nothing more than an apparatus for revolving a coil of wire near a magnet pole, or, more strictly, for revolving several coils of wire between two magnet poles. Between these poles is the "armature," consisting of a number of coils of wire so mounted on an axis as to be capable of revolution. If this armature be revolved by any means whatever, such as a steam engine, a current of electricity will be produced in the coils, which will pass to the outside wires by means of the stationary brass strips or "brushes." For convenience, this wire is usually wrapped around the magnets, in order to avoid using an external source of electricity to produce the magnetism. Now, though the shape of the magnets and the armature may be varied in a thousand ways, this is all there is in a dynamo that is essential.

If the armature is not revolved, no electricity is, of course, produced; but if we send a current of electricity from an external source through the dynamo, it at once revolves in the opposite direction, exactly as would a rotary pump if we sent a stream of water through it, and the amount of work which the dynamo or motor will be capable of doing will depend entirely on its size and the amount of current sent through it.

Perceive the simplicity of this engine—a heavy and strong electro-magnet, a pair of brass brushes, and one revolving part, the armature composed of wrought iron wrapped with copper wire and strengthened with metallic bands. This is all: no valves, no stuffing boxes, no glands, no packing, no crank pins, no reciprocation of parts, with consequent and inevitable lost motion, no water in cylinders, no perceptible radiation of heat, no smell, no thump, and almost no liability to get out of order. Any one desiring to see for himself the uniform and unattended performance of an electric motor can easily get permission to visit the operating room of the Gold and Stock Telegraph Co., in New York, and watch the electric motor running the transmitter which furnishes stock quotations to the city. It requires very little familiarity with the printing telegraph to perceive that the transmitter which controls quotations involving millions of dollars must run with absolute regularity under all conditions; and the visitor will find in one corner of the room, out of the way, and almost out of sight, a motor of about 3 horse power, running so silently as to be almost inaudible. And there it has run for three years, patiently performing its allotted task, simply asking that its two or three oil cups are occasionly filled, and its two brass brushes occasionally replaced. Yet the armature is balanced so nicely that it would require very long continued neglect of oiling to do much harm, and the only injury that would occur if the brushes were neglected for, say, a day would be one easily remedied, and unattended with the slightest danger.

On board the Atlanta we have a steam capstan on the forward berth deck, supplied with steam by a 4 in. pipe and connected to the auxiliary condenser by a $4\frac{1}{2}$ in. pipe. By reason of the distance between this engine and the boilers, with the consequent friction in the pipes and condensation, the steam pressure is much reduced, and the back pressure much increased, so that a larger engine is necessary than would otherwise be the case, and which is not astonishing. It has been known to run very much faster in weighing anchor, when exhausting into the atmosphere and covering the forecastle with a cloud of steam, than when exhausting into the condenser. Now, an electric motor for running the capstan would not only have the advantages already mentioned, but could be connected with the same main wires as those furnishing the electric lights by two wires, say $\frac{1}{4}$ in. diameter, thus avoiding altogether the expensive copper pipes, tinned on both sides and lagged.

The same remarks apply to the blowing engines, and one has simply to watch for a few minutes the compara-

* From the *Army and Navy Journal* (U. S.).

tive performance of even the best steam blowing engine and an electric motor, with the fan on the same shaft, to become convinced of the superiority of the latter.

For pumps, except the pumps very near the boilers, where the length of piping is short, electric motors would have the advantages mentioned above, and no disadvantages whatever.

For steering engines the simplicity of the apparatus, the quickness with which the motor could be handled, its freedom from liability to derangement, its absence of heat, and its noiselessness would commend it to any one who has ever been shipmate with a steam steering engine like the one on board the Atlanta, which, though efficient and reliable, is as complicated as a printing telegraph, keeps the after end of the ship almost at a cherry-red heat, and threatens to shake the teeth out of the officers and crew every time the helm is put hard over.

Three years ago the ability of electric motors to train guns was shown to the authorities in England, and since that time much progress has been made in perfecting the apparatus for applying electric motors to this kind of work. Little difficulty has been experienced, for though there is nothing that requires such accurate and rapid handling as a great gun in a seaway, there is no other engine capable of such accurate and rapid work as an electric motor, and its advantages over steam, hydraulic, and pneumatic engines are so marked that it would be idle to compare them. The indications now are that we shall have at least one gun in the Chicago trained by electricity, though possibly this may not be done, since the dynamos for generating the necessary electricity have been placed above the water line and exposed to the enemy's projectiles, while the beef, pork, bread, etc., have been placed below the water line and securely protected therefrom.

But it is not in the training of the guns alone that motors can be advantageously employed; they can also be used in elevating. In the Atlanta, when rolling from 10° to 20° each side, and from ten to twelve times per minute, the line of sight of the guns sweeps past the horizon so fast, even near the end of a roll, as to require from the gun captain a rare degree of skill if we would have him shoot as accurately as such fine guns should be shot. The trouble is that the gun is beyond his control except in the matter of training, because the most that he can do is to wait for a favorable time of roll and catch the line of sight on the target as best he can. To use the gun effectively he needs some arrangement by which he can put the gun on the target and keep it there, independently of the rolling of the ship. He needs some arrangement like the shoulder piece of the Hotchkiss guns, by means of which experiments on this ship have shown a very little practice enables a man to keep the line of sight almost exactly on the horizon or on any other object.

Electricity puts this power directly into the hand of the gun captain, for by means of a small electric motor on the elevating gear and a suitable switch he can raise, or lower, or stop the gun by simply moving his hand. The gun captain being able to train the gun to the right or the left, and to raise it up or down, the only thing left to do is to give him an electric primer, fired by means of an ordinary "push button," so that he can fire the gun quickly when the sights come on, instead of losing time by hauling on a lock lanyard.

The advantage of this quick means of firing by using the electric primer stands out clear when we recollect that in a ship, say the Atlanta, which rolls in a seaway about 3° per second on the average, an error on the part of the gun captain of only $\frac{1}{10}$ of a second of time means a vertical error, on a target a sea mile distant, of about 31 ft. This remark applies, of course, only to the individual firing, and not to broadside firing by electricity, the advantages of which are not so palpable.

A very neat use for electric motors would be for hoisting ammunition. On board the Atlanta we use five men at each shell hatch, and their work could be done more quickly and quietly by a 2 horse power motor costing, say, $200. This would require one man to operate it, and would leave four men from each hatch for work at the guns. Coal could be similarly hoisted on board, and how refreshing it would be in coaling a ship to see two 5 horse power motors running up the coal bags, instead of a long line of dirty men, hopelessly dragging on the yard and stay from morning till night, while the officer of the deck, a respectable man of forty, and the father of a family, incessantly and mechanically bawls at them to "haul away!"

But it may be objected that electric motors entail loss of energy, since steam engines use steam direct from the boilers, whereas motors require dynamos to generate the necessary current, the dynamos themselves being turned by steam engines, so that there are two losses—one loss in converting the mechanical energy of the steam engine into electrical energy, the other loss in reconverting the electrical energy of the current into the mechanical energy of the motor, to this it may be answered that 15 per cent. loss for each transformation is a very fair allowance, so that the motor would deliver about 72 per cent. of the energy of the dynamo's engine; and it may be doubted if the auxiliaries which are at any considerable distance from the boilers work with more than 72 per cent. of the difference in pressure between the boilers and the condenser, by reason of the loss in friction and condensation in the steam and exhaust pipes. In fact, in engines which run intermittently, like capstan, steering, and gun training engines, it may be doubted if any such efficiency as this is even approximated. This is a fair comparison, because the dynamo engine can be very near the boilers.

Since all our new ships are fitted with dynamos for feeding electric lights, why not have them feed electric motors also. every horse power developed by the motors being about the same thing as adding, say, nine 16 c. p. lights. Of course, the dynamos must be safe below the water line, and they must all be similar, and feed into the same main wires, which go all through the ship like gas pipes through a city, the incandescent lights, search lights, and motors receiving their supply from these main wires, and one, two, or three dynamos being run at a time, according to the number of lights and motors in use. Nothing could be more simple and effective than such an arrangement, and nothing could contribute more to the efficiency, health, and comfort of a ship.

To summarize, the advantages of electric motors in ships and forts over steam, pneumatic, and hydraulic engines are:

1. They are more simple.
2. They are more durable.
3. They are more quiet.
4. They are more clean.
5. They have no swell.
6. They require less attention.
7. They avoid the troublesome and very expensive operation of leading steam and water pipes through a ship, especially through water-tight bulkheads.
8. The wires take up less space than pipes—a great point in crowded engine rooms and fire rooms.
9. A water or steam pipe presents a much larger target than a wire, and is therefore more liable to be struck in action.
10. If a steam pipe or a water pipe is struck in action, the deck is filled with scalding steam or is flooded with water under high pressure. All the engines depending on it are put *hors de combat*, and it is quite impossible to repair it; whereas, if an electric wire is so struck, it can be repaired in a minute by simply bridging the gap with a wire.
11. The electric motor places in our grasp the best known means for handling guns, by reason of the readiness with which it is controlled.

In any ship arranged with a central of electric power and with main wires leading therefrom all over the ship, so that any desired amount of power could be obtained by simply moving a button as in lighting an incandescent lamp, a number of small portable motors could be placed wherever desired about the decks, and employed for such purposes as hoisting ammunition, coal and ashes, working the yard and stay, running lathes in the ordnance and engineer workshops, running small ventilators, etc.

The writer is aware that, in representing the benefits to arise from the use of electric motors on shipboard, he will fall under the disapproval of many of the best officers, who deem it unsailorlike to do ship work with machinery. But he feels assured that the navy is daily losing much by not seizing the advantages offered by electric motors, and that there are many officers who believe that the navy should not only preserve the glorious traditions of the past, but should also grasp the possibilities of the present. Let these note that, as said above, electric motors are no longer scientific or "theoretical" curiosities, but practical and strong machines, waiting simply to be used in order to contribute to the effectiveness, health, and comfort of our ships and forts, and that they can be bought in open market, or by advertisement, like beef and pork, and can be stowed on either the port or the starboard side. It is as certain as anything can be that naval and military people will some day use them. The only question is, will we be as slow in taking advantage of them as we were in taking advantage of steam capstans, steam steering engines, steel ships, and square air ports?

NOTES ON THE STRUCTURE OF THE QUILLS OF THE PORCUPINE.

By EDWARD G. GARDINER, Ph.D.

THE hair and quills of the common North American porcupine (*Erethizon*) present some marked peculiarities. The back and sides of the animal are covered by long shaggy hairs, varying in color from brown to black, and frequently tipped with white.

These hairs are quite coarse, and often from four to five inches in length. The head, limbs, and belly are clothed with much shorter hairs, which are generally of the same color as the long ones, except that they are seldom tipped with white. On the back and rump, interspersed with the long hairs, are numerous long, slender quills, which, unlike the hairs, are white in color, tipped with black. These quills are about one twenty-fourth of an inch in diameter throughout their entire length (4 or 5 inches) till within one quarter of an inch or so of the extremity, at which point they decrease rapidly in size, terminating in an exceedingly fine point. These quills, which are easily bent or broken, constitute but a small portion of the protective armament of the porcupine. The animal is further provided with very numerous short and exceedingly stout quills, from one to two inches in length, and of about twice the diameter of the long and slender ones. Like these latter they are white, and somewhat resemble the shaft of a feather in appearance. On the head, back, and sides these short quills are very numerous, although partially concealed by a thick growth of hair, such as clothes the limbs and ventral side of the body. On the tail, however, the quills are more numerous, and as the hair is much shorter, the quills are evident to the most superficial glance.

It is well known that when disturbed or irritated, the porcupine erects the hair and quills, at the same time striking at its assailant with its powerful tail. In the act of striking, when the tail is suddenly arrested by coming violently in contact with some obstacle, the shock is frequently sufficient not only to detach some of the quills, but to throw them a short distance. It is stated on good authority that the muscular contraction by which the quills are erected may cause some of them to be detached and ejected.

The manner of growth of the quills explains why some of them are so easily loosened. The quill, like an ordinary hair, grows from a papilla, which fits into the cup shaped depression of the root (Figs. 1 and 2), and which lies embedded in the *cutis vera*.

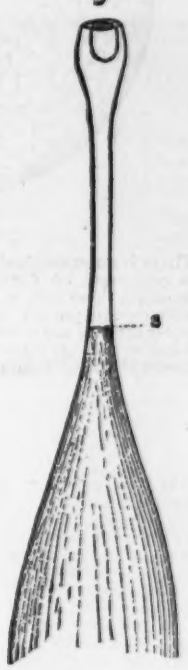
Fig. 1 shows the root of an immature quill enlarged about fifteen diameters, the point of which protruded about one half an inch. There is no difference in size between the root and the part which is immediately above the skin. At this stage in its development the quill is very firmly attached, requiring considerable force to pluck it out. Fig. 2, on the other hand, shows the root of a full grown quill which was detached by a slight shock. It will be seen that the root has in a measure atrophied, being less than half the diameter of the actively growing quill. In other quills which have dropped out the bulb (*a*) at the root is even smaller, and shows evidence of even further degeneration.

If the rate of growth during the formation of the whole quill is uniform, it is evident that when the part immediately below the line (*s*) was formed, the papilla must have been undergoing very rapid diminution in size. Quill roots showing different stages of degenerati on have also been observed. The structure of the attenuated part of Fig. 2 is closely similar to that of the rest of the quill—the principal difference being that the former is much less horny. In quills treated with picro-carmine this is the only part which takes the red stain. During the growth of the slender part, the papilla not only changes in size, but also in position.

In the young quill, which projects but one-half an inch or so above the skin, the root is very deeply embedded in the subcutaneous tissues. When, however, the papilla begins to dwindle, it also begins to change its position, by growing up toward the surface. Hence

Fig 1

Fig. 2.



at the same time that the quill is being forced out by growth from the papilla at its base, the papilla itself is also traveling upward. The root of a young quill is often buried in the *corium* a quarter of an inch deep, while that of one which has reached its maximum development is seldom embedded to half that extent. The letter (*s*) in the Figs. 1 and 2 shows the point up to which the quills were embedded.

When the quill is fully developed it loosens itself and drops out. Whether the papilla which has borne it then dies, or whether it proceeds to build a new quill, is somewhat uncertain, though it would appear that the latter is the case. Young quills, the points of which are hardly above the surface of the skin, have their papillæ so close to the surface that the thought

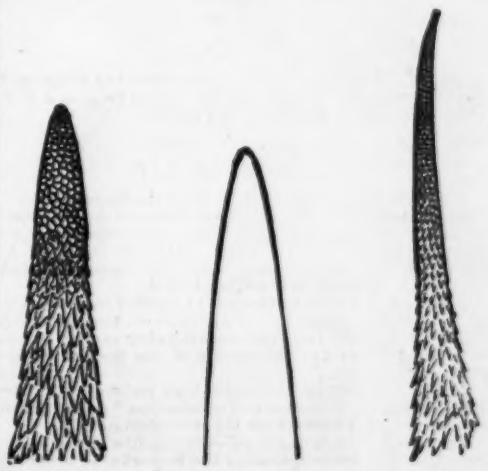


FIG. 3. FIG. 4. FIG. 5.

that the papillæ are the ones which have just shed their quills naturally suggests itself.

It should be remarked here that, owing to the exceeding hardness of the quills, great difficulty in obtaining sections fit for microscopic examination was experienced. The quills themselves can be cut only after prolonged treatment with caustic potash. From such sections as have been obtained, however, it would appear that after the quill had fallen out or been shed, the papilla begins immediately to build a new quill, at the same time sinking deep into the *corium*, as before described.

When the point of the quill is first thrust above the surface of the skin, it is perfectly smooth and quite soft, being easily bent. As it grows longer it seems to

dry up, and become much harder and stiffer. At the same time small plates appear on the surface, and shortly afterward these plates assume the form of barbs (Figs. 3 and 5).

These figures are from camera drawings of quills magnified about fifteen diameters. Some idea of the exceeding sharpness of their points may be gained by comparing them with Fig. 4, which represents the extremity of a No. 12 sewing needle magnified to the same extent. No. 12 is nearly, if not quite, the smallest sewing needle that is used.

The quills are not solid in structure except near their points. In cross sections, as in general appearance, they very much resemble the shaft of a feather. Fig. 6 shows a section magnified about sixty diameters.

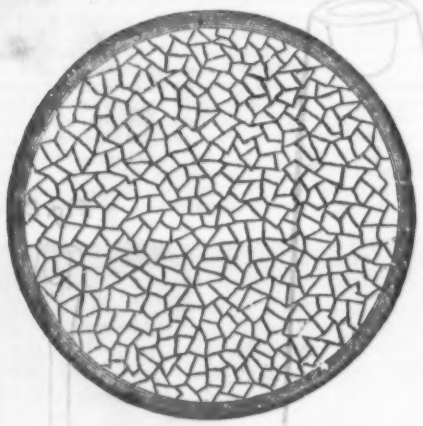


FIG. 6.

There is an exceedingly hard, stiff cortical part, which is composed of flattened, fusiform horn cells. To separate these cells so that they are visible, treatment with caustic potash is advisable. Within this harder outer layer is the medullary cavity, which is generally filled with large pith-like cells. For the most part all traces of the original contents of these cells have disappeared, though occasionally oil or fat drops are present. —*Technology Quarterly.*

HABIT OF VESPA.

WHILE going through a swamp filled with alder bushes I noticed, hanging in the middle of one, a wasp devouring a fly in the position shown in the drawing. The wasp hung down by one foot. The abdomen was bent up out of the way. The half-eaten fly was held by the front feet, while the other legs and wings stuck out carelessly in all directions. As the mandibles and antennæ kept in rapid motion and the fly was turned over and over by the forefeet, the wasp swung slowly back and forth with the same appearance of comfort and enjoyment as a man eating an apple in a

hammock. When the fly had been reduced to wings and shell the wasp let it drop, got up on the twig, and flew away.—*James H. Emerton, in Psyche.*

TORPEDO MARMORATA.

A PAPER was recently read before the Royal Society, London, entitled, "Further Observations on the Electromotive Properties of the Electrical Organ of *Torpedo marmorata*." By Francis Gotch, Hon. M.A. Oxon., B.A., B.Sc. London, M.R.C.S. Communicated by Prof. J. Burdon Sanderson, F.R.S.

The author details the results of further observations as to the electromotive properties of the electrical organ of torpedo, the experiments being carried out in October, 1887, at the laboratory of the Societe Scientifique d'Arcachon.

I. The first part of the work deals entirely with the phenomena of "irreciprocal conduction" in the organ of torpedo, as described by Du Bois-Reymond.

From Du Bois-Reymond's experiments it would appear that the organ possesses the remarkable property of conducting an intense current of short duration, led lengthwise through its columns, better when the current is directed from its ventral to its dorsal surface than when directed the reverse way. The former direction coincides with that of the current of the shock of the organ, and is therefore termed by him 'homodromous;" the latter, being opposite in direction, is termed "heterodromous." The evidence rests upon the value of the galvanometric deflections obtained when both currents are allowed to traverse a strip of organ and a galvanometric circuit. The deflections are markedly unequal, particularly when induced currents are used, the homodromous effect being always much greater than the heterodromous. The homodromous current must therefore either encounter less resistance than the heterodromous, or its electromotive force must be suddenly strengthened, and that of the heterodromous current weakened, by the sudden establishment in the tissue of a new source of electromotive energy. The first is the view taken by Prof. Du Bois-Reymond.

(1) The present rheotome experiments reveal (*a*) the new fact that the passage of such intense currents of short duration is always followed by an excitatory response (shock) in the tissue; (*b*) that if the intense current due to this response is allowed to affect the galvanometer as well as the induced or other exciting current, then by obvious algebraic summation the homodromous deflection must be much larger than the heterodromous; (*c*) and that when by means of a fast-moving rheotome the induction shock only is allowed to affect the instrument, no irreciprocity is found.

The author therefore assumes that the phenomena of irreciprocal conduction are in reality excitatory phenomena, the nature of which, from the methods of investigation used, have not been recognized.

(2) The time relations of this response of the isolated strip of the organ to direct stimulation by the traversing induction shock are now for the first time investigated, by means of the rheotome, and the influence of temperature and other conditions upon these is shown by experimental evidence.

II. The second part deals with entirely novel phenomena—namely, the excitation of the organ by the current of its own excitatory state. It is shown that in vigorous summer fish every response of the whole or part of the organ to a single excitation of its nerves is followed by a second response, due to the passage through its own substance of the intense current of the first response. In other words, the shock of the organ excites its own nerve fibers and nerve endings, producing a feebler second shock, which in a similar manner evolves a feebler third shock; this a fourth, and so on.

The response of the isolated organ to nerve excitation is thus multiple; a primary, secondary, tertiary response following the application to the nerve of a single stimulus. Since all these responses produce currents similarly directed through the columns of the organ, each column during its activity must re-enforce by its echoes the force of the primary explosion, both in its own substance and also in that of its neighbors.

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